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DIPHTHERIA CARRIERS AND THEIR SIGNIFICANCE IN THE PHILIPPINES

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Previous papers have demonstrated the low incidence of diphtheria among Filipinos, although it was also shown that Filipino children are just as susceptible to diphtheria infection as are the children of other races.[1]

The next step in the study of the local diphtheria situation would be the study of the incidence of diphtheria carriers and the significance of the bacilli harbored by them, which might have a bearing on the low incidence of the disease, and such data might prove valuable from the standpoint of public sanitation. With this object in view we have made careful cultural studies of material obtained from the throats of about 1,775 healthy individuals to determine the prevalence of diphtheria carriers in the Philippines, and animal tests have been performed to determine the virulence of the different strains of diphtheria bacilli isolated in pure culture.

MATERIAL AND TECHNIC

The search for carriers was started on account of a case of clinical diphtheria that occurred in a pupil attending the Santa Clara Public School, Manila. We examined 990 children of various ages attending the Santa Clara Public School, many of whom had been in more or less intimate contact with the case of clinical diphtheria reported; 232 children from 1 to 15 years old, inmates of the Philippine Government Orphanage at San Pedro Macati, near Manila, where no diphtheria has ever occurred since the establishment of the institution in 1917; and 553 male and female adults of Bilibid Prison where diphtheria has never been known to occur.

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[1] Gomez, Liborio; Kapauan, Amando M.; and Gavino, Catalino, Diphtheria in the Philippine Islands, Philip. Journ. Sci. 17 (1920) 37. Gomez, Liborio; Navarro, Regino; and Kapauan, Amando M., The Schick reaction in Filipinos, Philip. Journ. Sci. 20 (1922) 323.

One specimen was taken from each child and in cases where the results were doubtful another specimen was obtained. With the aid of a wooden tongue depressor, the tonsils and pharynx were swabbed with a sterile cotton pledget attached at the end of a small applicator stick. The swab was rubbed against the tonsils and pharynx by revolving the stick in the fingers in such a way as to bring the swab thoroughly in contact with the tonsils and the lacunæ or with any area at the pharynx that looked suspicious. The infected swab was then inserted into a Loeffler's serum tube and rubbed gently back and forth over the entire surface of the serum, revolving the stick so as to bring the swab in thorough contact with the serum, avoiding at the same time any break in the surface of the slant; and afterwards the swab was thrown away.

The inoculated Loeffler's blood serum tubes were taken to the laboratory and after incubation of from eighteen to twenty-four hours at 37° C. the cultures were examined, and all suspicious colonies (whitish, pearly, rather elevated) and the bottom of the tube (when there was proteolysis of the serum) were examined microscopically. The smears were stained with Loeffler's methylene blue, and the colonies showing suspicious bacilli were either fished out with a fine platinum needle and transplanted to several Loeffler's blood serum tubes in order to get discrete colonies, or plated in glycerine agar in order to be able to get pure cultures. In some cases one single colony was transplanted; in other cases several colonies were transplanted, especially when isolation was made by the glycerine agar plate method where the colonies are so small and hard to pick out with the point of the needle. In such cases a small area was marked out and examined microscopically to determine uniformity of colonies; the area was then rubbed over with a fine platinum loop and smeared on Loeffler's blood serum.

The morphology of the bacteria was studied in cultures from eighteen to twenty-four hours old, in Loeffler's blood serum, and stained with Loeffler's methylene blue, Neisser-Gin, and Gram's stain. In all cases we inoculated Hiss's serum carbohydrate media tubes of glucose, saccharose, and dextrin. For control purposes media of the same batch were simultaneously inoculated with known cultures of diphtheria bacilli, Park Williams 8, Xerosis bacillus isolated from the throat and from the eye, and Hoffmann's bacillus.

The isolated bacteria were considered diphtheria bacilli if they showed positive Gram's stain, typical arrangement, typical polar bodies, or metachromatic granules and, in Hiss's serum media, if the glucose was acidified strongly, the dextrin slightly, and the saccharose not at all, thus differing from the Xerosis bacillus which does not acidify dextrin but does acidify saccharose, while Hoffmann's bacillus does not acidify any of the three sugars used.

The virulence test was performed on all the strains isolated from the carriers. The test was performed by subcutaneous injection in the middle line of the abdominal wall of a guinea pig, weighing 250 to 300 grams, of 4 cubic centimeters of a 10-cubic-centimeter salt solution emulsion of a twenty-four hours old Loeffler's blood serum culture, according to the method of Kolmer and Moshage.[2] The criterion used in considering virulence of the bacilli was the following set of findings: Local subcutaneous œdema of the abdominal walls, hyperæmia of the adrenals, and death of the guinea pig within four days after inoculation.

INCIDENCE OF CARRIERS

All the organisms isolated were Gram positive bacilli of the granular type corresponding to the types B, C, and D of Wesbrook and, in one case, type E, which looks almost like a diplococcus when stained with Loeffler's methylene blue, but shows distinct granular bodies when stained with Neisser-Gin stain.

From 1,222 children of various ages, pupils attending Santa Clara Public School and inmates of the Philippine Government Orphanage at San Pedro Macati, there were isolated 32 pure cultures of diphtheria bacilli. From 553 adult males and females in Bilibid Prison, there were isolated 6 pure cultures. In all of these, the diphtheria bacilli were identified culturally, morphologically, and by the acid reaction in Hiss's carbohydrate media.

The total number of individuals examined, therefore, was 1,775, from 38, or 2.08 per cent, of whom pure cultures of diphtheria bacilli were isolated. The actual number of carriers in a group of healthy individuals is higher, because we often noticed in smears from the original cultures typical bacilli, which we were unable to isolate on account of too great contamination or of some defect in the technic, and because only one specimen was taken and examined from each individual in practically all cases. The above figures, however, give us a general idea of the existence of diphtheria bacilli in the throats of a group of healthy individuals in the Philippines.

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[2] Journ. Inf. Dis. 19 (1916) 1.

Two years after the first examination in the Philippine Government Orphanage at San Pedro Macati another survey was made of the inmates. There were 217 examined, including most of the children previously examined. Nine were found to harbor diphtheria bacilli, in the throat of one of whom the diphtheria bacilli had also been found two years previously.

Physical examination of the throat of the carriers failed to show anything characteristic, although many of them had moderately enlarged tonsils.

VIRULENCE TEST

Thirty-five of the thirty-eight cultures isolated were tested for virulence according to the method mentioned previously. The other three cultures were either spoiled or lost and no virulence test was performed with them. The results of these tests are shown in Table 1.

Four cultures (5, 23, 25, and 33) out of the thirty-five were considered virulent because the injected guinea pigs died within four days after inoculation, with subcutaneous œdema, usually hæmorrhagic, and intense congestion of the adrenals. One of the individuals harboring virulent diphtheria bacilli, M.M., a girl about 9 years old, developed clinical diphtheria two days after examination; and the other three (A.S. and N.C., school boys, and B75, adult male) have never shown clinical symptoms. Two other cultures (obtained from P.M. and I.L., school children) were considered slightly virulent, as the animals injected with them died after six days and showed slight local subcutaneous œdema and slight or distinct hyperæmia of the adrenals.

The other twenty-nine cultures were considered nonvirulent. Guinea pigs that die after injection of the virulent culture live longer than four days and death often occurs after a considerable period of time, either from intercurrent infection or from intoxication due to absorption of bacterial body proteids; death

TABLE 1.—*Virulence test of Bacillus diphtheriæ isolated from carriers at different times.*

Culture No.	Carrier.	Effect of injection on guinea pigs.			
		Subcutaneous œdema.	Congestion of adrenals.	Died after injection.	Alive after injection.
				Days.	*Days.*
1	P. M	+[a]	+	6	
2	C. P.	—	(a)	8	
3	F. A	—	+[a]	42	
4	T. S.	—	+	10	
5	M. M.[b]	+	+	[c]2	
6	C. C.	—	—	48	
7	V. S.	—	+[a]	18	
8	A. C	—			65
9	A. O	—	—	26	
10	J. P.	—			65
11	I. L	—	—	10	
12	A. V	—	+[a]	8	
13	S. A.	—	—	17	
14	J. E.	—			19
15	I. S.	—	+[a]	18	
16	D. R	—	+[a]	10	
17	F. A	—	—	22	
18	C. P.	—	—	36	
19	P. S.	—	—	43	
20	M. V	—			53
21	I. L	+[a]	+[a]	6	
22	J. L.	—	+[a]	18	
23	A. S.	+	+	[c]2	
24	F. M	—			52
25	N. C	+	+	[c]1	
26	J. L.	—	+ ?	33	
27	G. C.	—	—	5	
28	N. I.	—			6
29	G. W.	—			6
30	M. S	—			13
31	B3	+[a]	+[a]	22	
32	B38	—	—	21	
33	B75	+	+	[c]3	
34	B110	+[a]	+	12	
35	B156	—	—	13	

[a] Slight.

[b] This carrier developed clinical diphtheria two weeks subsequent to examination.

[c] Virulent cultures.

under those conditions is not distinguishable from the death of animals after injection of massive doses of other bacteria.

In no case were we able to notice paralytic symptoms in guinea pigs used in these tests indicative of diphtheria intoxication.

DISCUSSION OF FINDINGS

Graham-Smith,[3] tabulating the findings of several authors, found that 2.6 per cent of persons who have not come in contact with diphtheria cases harbor nonvirulent diphtheria bacilli, and 0.18 per cent harbor virulent bacilli.

The number of cases that we have examined is fairly representative of the entire population of Manila, although our findings, 2.08 per cent of healthy individuals being carriers, are necessarily low on account of our having examined only one specimen from practically all the cases. These findings are sufficient to establish the fact that there is a certain percentage of people in the population in Manila that harbor diphtheria bacilli; and that the diphtheria bacilli found in normal throats are usually nonvirulent, a small proportion being virulent; that is, four, or 11 per cent, of the thirty-five isolated, or about 0.22 per cent of the total number of people examined. This is in striking contrast with the findings in cultures of diphtheria bacilli isolated from clinical cases in San Lazaro Hospital, practically all of which have been found to be virulent. The nonvirulent bacilli isolated differ in no other respect, morphologically and culturally, from those isolated from the throats of patients suffering from the disease.

The work in the Santa Clara Public School was started on account of a case of diphtheria that occurred in one of the pupils. Another pupil (M.M.), in an entirely different room from the one that was first taken sick, was found to be a carrier of virulent bacilli and later developed a mild clinical diphtheria. All the carriers from the school were isolated at the San Lazaro Hospital, at different periods, and given treatment until the diphtheria bacilli disappeared. The work connected with the taking of specimens and the detection and isolation of individual carriers was done within a period of about forty days. No other cases of diphtheria developed in the school or among people with whom the two cases of diphtheria associated in their homes, although a sufficient period of time had elapsed, before the detection and isolation of the carriers, for the possible spread of the disease.

In the Government Orphanage at San Pedro Macati no case of clinical diphtheria has developed since its establishment in 1917, although carriers were found in the institution at the first examination, in 1919 (in one instance the bacilli were virulent), and there were children susceptible to diphtheria as shown by results of the performance of the Schick's test. In this institution we have data of the constant existence of carriers, in spite of the isolation of those detected previously. Two years later another examination was made of the inmates of the orphanage. From 217 inmates (most of whom had been examined two years previously) 9 pure cultures were isolated, all of which proved to be nonvirulent in the animal tests; also, one of the positive carriers (G.C.) was found to have harbored the bacilli two years previously.

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[3] Nuttall, G. H. F., and Graham-Smith, G. S., The Bacteriology of Diphtheria. Cambridge (1908) 194.

We see from the above that, in spite of association with clinical cases and with persons harboring diphtheria bacilli, the disease has not spread in a school (Santa Clara) with a daily attendance of about one thousand. In an institution (Philippine Government Orphanage) where there is more or less intimate association among the children, and where there were always carriers and persons susceptible to the disease, clinical diphtheria has never been known to develop in the five years of its existence. In another institution, Bilibid Prison, no diphtheria has been known to occur for some years before these carrier examinations were made, in spite of the existence of carriers of avirulent and of virulent diphtheria. It is the present consensus that diphtheria bacilli which are found by laboratory test to be nonvirulent are not harmful to human beings, and healthy persons harboring nonvirulent bacilli need not be isolated. This criterion has been recently confirmed experimentally by inoculation of the throats of human beings with virulent and with nonvirulent diphtheria bacilli by Guthrie, Marshall, and Moss.[4]

SUMMARY

1. At least a certain percentage (2.08) of healthy individuals in the Philippine Islands harbor diphtheria bacilli in their throats.

2. The diphtheria bacilli harbored in healthy persons have been found nonvirulent in about 89 per cent, and virulent in about 11 per cent of the carriers.

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[4] Moss, W. L.; Guthrie, C. G.; and Marshall, B. C., Experimental inoculation of human throats with avirulent diphtheria bacilli, Johns Hopkins Hosp. Bull. 32 (1921) 37. Guthrie, C. G.; Marshall, B. C.; and Moss, W. L., Experimental inoculation of human throats with virulent diphtheria bacilli, Johns Hopkins Hosp. Bull. 32 (1921) 369.

3. In a school where two cases of clinical diphtheria developed and where carriers of both nonvirulent and virulent bacilli were found, the disease has not spread to the other children of the school or to the other people with whom the carriers and cases came in daily intimate association, which confirms the notion that the disease does not become epidemic in Manila.

4. In spite of the continuous existence of carriers of nonvirulent bacilli and the occasional existence of virulent ones in persons living in institutions where a certain number have been proved to be susceptible to the disease by Schick's test, no clinical diphtheria has ever been known to develop among the inmates.

5. From the above data one must conclude that, for the control of diphtheria in the Philippines, it is only necessary to examine the throats of the individuals who have come in intimate contact with cases, to isolate those who are carriers, and to liberate them later if the animal tests show that the bacilli they harbor are not virulent.

ACKNOWLEDGMENT

We desire to express our appreciation of the courtesies extended us by Dr. Antonio Mañalac, of Bilibid Prison, and by Dr. Severo Siasoco, of the Philippine Government Orphanage.

HYPERSENSITIVENESS OF PHILIPPINE DOGS TO STRYCHNINE

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INTRODUCTION

The belief has long been entertained by some veterinarians of the Philippine Islands that native dogs possess a hypersensitiveness to the action of strychnine sulphate and other salts of that alkaloid. This belief is founded entirely upon personal experience in administering the drug to these animals with untoward results, so that the grounds are essentially empirical and without scientific basis. Reports, however, have been so numerous of cases wherein strictly therapeutic doses of strychnine sulphate have produced the characteristic symptoms of acute strychnine poisoning as to give great weight to the view, and the opinion may be said to have become confirmed in the minds of many.

As an illustration of these unfavorable clinical sequelæ which have apparently occurred so often, an experience may be cited which I had while employed as an assistant in a veterinary hospital in Manila. To each of two pups, weighing between 5 and 6 kilograms each, was given a tablet of triple arsenites, containing $\frac{1}{120}$ of a grain of strychnine arsenite to the tablet, an amount not in excess of that indicated in most textbooks. The intention was to administer one of these tablets daily, but about twenty minutes after the administration of the second dose acute convulsive attacks in both animals occurred. These attacks increased in intensity as they recurred until death ensued, about thirty minutes after the administration of the drug.

The dose of strychnine by the different channels of administration for dogs in temperate climates has been carefully determined by various workers, but to my knowledge no similar work has been undertaken under tropical conditions, and certainly not locally. Therefore, in view of the foregoing considerations the question naturally arises: Does the apparent hypersusceptibility of native dogs to strychnine actually exist, or can the unusual effects so often manifested be accounted for in some other manner? The experiments that form the subject of this paper were undertaken with the object of inquiring into this phase of the matter and of endeavoring, if possible, to throw some light of a definite nature upon this interesting but rather moot question.

REVIEW OF LITERATURE

The therapeutic dose of strychnine sulphate as given by veterinary textbooks falls between 0.0003 and 0.003 of a gram ($\frac{1}{200}$ to $\frac{1}{20}$ of a grain). Udall(13) gives 0.001 to 0.003 gram ($\frac{1}{60}$ to $\frac{1}{20}$ grain) as the dose for internal administration and one-half of this amount for subcutaneous use. Brumley(1) gives 0.00104 to 0.00302 gram ($\frac{1}{62}$ to $\frac{1}{21}$ grain)[1] and Frohner,(3) 0.001 to 0.003 gram ($\frac{1}{70}$ to $\frac{1}{25}$ grain). Dun(2) fixes the maximum at 0.00065 to 0.0013 gram[1] ($\frac{1}{100}$ to $\frac{1}{50}$ grain) and writes that tablets and lamellæ containing 0.001 to 0.0006 gram[1] ($\frac{1}{60}$ to $\frac{1}{100}$ grain) of strychnine sulphate are convenient for subcutaneous injections. Winslow(14) gives 0.0003 to 0.0015 gram ($\frac{1}{200}$ to $\frac{1}{40}$ grain) advising that the larger doses are to be given when administered orally. He states further that these doses may be given every three hours without producing poisoning by accumulation. On account of the extreme susceptibility occasionally observed, particularly in dogs, Winslow,(14) Udall,(13) and Frohner(3) advise that all doses should be apportioned to the body weight, and fix the dose at 0.0001 gram ($\frac{1}{600}$ grain) per kilogram of body weight for subcutaneous injections.

Concerning the elimination of strychnine there is more discrepancy among the various reports. On the one hand, Lander(9) is authority for the statement that the elimination of strychnine is not complete even in three days; Plugge(11) states that although strychnine appears in the urine two hours after its injection traces may be found as late as the eighth day; this statement is supported by Winslow,(14) who says that strychnine may be found in the urine from three to eight days after its administration. On the other hand, according to Kratter,(8) the excretion of strychnine is complete at the expiration of forty-eight hours. In two experiments performed by Hale,(4) on a normal healthy human adult weighing 160 pounds (about 73 kilograms), with strychnine sulphate given by the stomach he found complete elimination after five days. Mostrom and

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[1] Computation is mine.—M. M.

McGuigan,(10) testing for the presence of strychnine nitrate, at weekly intervals in no less than forty-eight frogs obtained a negative result in every instance.

The fatal dose of strychnine is given by Dun(2) and by Lander(9) as 0.0054 to 0.0216 gram[2] (1/12 to 1/3 grain). Winslow(14) found this dose to be "much too large." He injected 3.24 milligrams (1/20 grain) of strychnine nitrate subcutaneously into a dog weighing 25 pounds (0.29 milligram per kilogram)[2] and observed tetanic convulsions within ten minutes. He also reports cases where toy terriers were killed by 1.08 milligrams (1/60 grain) of the alkaloid. Kaufmann(6) and Kobert(7) give 0.75 milligram per kilogram as the fatal dose, but Hale(4) found this dose "entirely too large." Hoare(5) observed several cases of intoxication after administering so-called therapeutic doses of strychnine and writes that the doses advised in his work are "too large and that greater care is necessary in prescribing them in full doses." More specific figures are given by Sollmann,(12) who determined the minimal lethal dose per kilogram of body weight by the different channels of administration to be as follows: By the stomach, 1.2 to 3.9 milligrams; subcutaneously, 0.35 to 0.75 milligram; intravenously, 0.4 milligram; by the rectum, 2 milligrams; and through the bladder, 5.5 milligrams.

PROCEDURE

The experiments described in the following pages were conducted in the College of Veterinary Science, University of the Philippines, Los Baños, from March 6 to July 31, 1922. Twelve dogs were utilized in the work, of which ten were obtained from the Manila City Pound and two in the vicinity of Los Baños. The salt of strychnine used was the sulphate (Park Davis and Company, Detroit, Mich., U. S. A.) in the form of friable tablets containing 0.5 grain each. Enough of these tablets were placed in a volumetric flask with sufficient water to make 1,000 cubic centimeters of a 1 to 1,000 per cent solution. The frequency of the administration of the solution throughout the experiment was at intervals of seven days. The live body weight of each dog was ascertained by weighing previous to each administration of the drug, and the dosage was apportioned in accordance with this determination. Following the administration the animals were placed under conditions which simulated as closely as possible those to which they had been accustomed. During the early part of the experiment and before the appearance of convulsive symptoms the recording of the pulse, respiration, and temperature constituted a part of the regular procedure. Close observation was made for any increase in reflexes that might be manifested, and the results of such observations were carefully noted. The effects of strychnine produced in the varying doses employed by the various channels of administration are shown by the data which follow. The experiments were so conducted that two dogs received the drug by mouth; four, subcutaneously; two, intravenously; three, by rectum; and one, intramuscularly.

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[2] Computation is mine.—M. M.

RESULTS

The results of these experiments are given in five tables. Table 1 gives the results of administration by mouth. The mouth was carefully lubricated with molasses and the calculated amount of strychnine sulphate was given by means of a

TABLE 1.—*Dogs receiving strychnine sulphate by mouth.*

DOG 1, ADULT FEMALE.

Date.	Weight.	Dose in milligrams per kilogram.	Remarks.
	Grams.		
April 24	8,200	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 1	8,300	0.075	Do.
May 8	8,400	0.1	Reflexes slightly increased after 29 minutes.
May 15	8,400	0.175	Reflexes increased after 27 minutes.
May 22	8,200	0.25	Reflexes increased after 23 minutes.
May 29	8,200	0.35	Just convulsive after 20 minutes.
DOG 2, ADULT MALE.			
April 24	6,000	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 1	6,200	0.075	Do.
May 8	6,400	0.1	Reflexes increased after 23 minutes.
May 15	6,300	0.175	Reflexes markedly increased after 34 minutes.
May 22	6,600	0.25	Reflexes markedly increased after 20 minutes.
May 29	6,600	0.35	Just convulsive after 21 minutes.
June 5	6,400	0.47	Just tetanic after 15 minutes.
June 12	6,800	0.8	Tetanic convulsions.
June 19	7,000	1	Just fatal after 33 minutes.

TABLE 2.—*Dogs receiving subcutaneous injections of strychnine sulphate.*

DOG 3, ADULT FEMALE.

Date.	Weight.	Dose in milligrams per kilogram.	Remarks.
	Grams.		
April 25	7,400	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 2	7,400	0.075	Do.
May 9	7,000	0.1	Reflexes markedly increased after 15 minutes.
May 16	7,000	0.13	Reflexes markedly increased after 13 minutes.
May 23	7,400	0.175	Just convulsive after 9 minutes.
May 30	7,600	0.25	Just tetanic after 12 minutes.
June 6	7,600	0.35	Tetanic convulsions.
June 13	7,600	0.47	Just fatal after 21 minutes.
DOG 4, ADULT FEMALE.			
April 25	6,800	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 2	7,300	0.075	Do.
May 9	6,600	0.1	Reflexes not markedly changed.
May 16	6,800	0.13	Reflexes markedly increased after 15 minutes.
May 23	7,200	0.175	Just moderately convulsive after 19 minutes.
May 30	7,400	0.25	Just tetanic after 18 minutes.
June 6	7,400	0.35	Tetanic convulsions.
June 13	7,600	0.47	Do.
June 20	7,600	0.60	Do.
June 27	7,800	0.75	Just fatal after 16 minutes.
DOG 5, ADULT MALE.			
June 24	7,400	0.25	Just convulsive after 42 minutes.
July 1	6,800	0.35	Convulsion after 22 minutes.
July 8	7,000	0.47	Just tetanic after 20 minutes.
July 15	7,000	0.60	Tetanic convulsions.
July 22	7,400	0.75	Just fatal after 40 minutes.
DOG 6, ADULT MALE.			
March 6	8,000	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
March 13	8,000	0.075	Do.
March 20	8,200	0.1	Marked increase of reflexes.
March 27	8,000	0.175	Do.
April 3	8,000	0.20	Just convulsive.
April 10	8,100	0.25	Just tetanic.
April 17	8,200	0.35	Just fatal.

TABLE 3.—*Dogs receiving intravenous injections of strychnine sulphate.*

DOG 7, ADULT FEMALE.

Date.	Weight.	Dose in milligrams per kilogram.	Remarks.
	Grams.		
April 26	8,800	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 3	8,800	0.075	Immediate acceleration of reflexes.
May 10	8,600	0.1	Do.
May 17	8,000	0.13	Convulsion after 30 seconds.
May 24	8,000	0.175	Tetanic convulsions.
May 31	8,600	0.25	Do.
June 7	8,400	0.35	Do.
June 14	8,500	0.4	Fatal after 3 minutes.
DOG 8, ADULT MALE.			
April 26	7,400	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 3	6,700	0.075	Immediate acceleration of reflexes.
May 10	6,800	0.1	Do.
May 17	6,800	0.13	Just convulsive.
May 24	6,600	0.175	Tetanic convulsions.
May 31	6,800	0.25	Do.
June 7	6,800	0.35	Fatal after 12 minutes.

hypodermic syringe provided with a long needle the end of which had been rounded off. No difficulty was experienced in giving the drug.

Table 2 gives the results of subcutaneous injections. The site selected was the costal region on either side of the chest.

Table 3 gives the results of intravenous administrations. The dogs were carefully secured and the injections were made into either the posterior auricular or the external metatarsal vein. The solution was injected at body temperature.

Table 4 gives the results of rectal administration. The animals were allowed to defecate before the drug was given and if fæces were not passed the rectum was manually cleaned out before each administration. The calculated amount of the solution to be used was each time heated to body temperature and administered by means of a syringe provided with a long, bluntpointed needle around which a wide elastic band had been rolled, and on top of which a thick layer of vaseline was applied. The animals were kept absolutely quiet for a period of ten minutes to avoid tenesmus and rejection of the solution administered, thereby insuring its absorption.

Table 5 gives the results of intramuscular administration. The site of injection selected was the fleshy portion of either thigh.

TABLE 4.—*Dogs receiving strychine sulphate per rectum.*

Date.	Weight.	Dose in milligrams per kilogram.	Remarks.
DOG 9, ADULT FEMALE.			
	Grams.		
April 27	8,000	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 4	8,000	0.075	Do.
May 11	8,600	0.1	Do.
May 18	8,400	0.13	Reflexes increased.
May 25	8,000	0.175	Reflexes greatly increased.
June 1	8,400	0.25	Do.
June 8	8,800	0.35	Do.
June 15	8,800	0.60	Tetanic convulsions.
June 22	8,800	1	Do.
June 29	8,800	1.5	Fatal after 20 minutes.
DOG 10, ADULT MALE.			
April 27	5,700	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 4	6,000	0.075	Do.
May 11	6,800	0.1	Do.
May 18	6,600	0.13	Reflexes increased.
May 25	6,000	0.175	Reflexes greatly increased.
June 1	6,200	0.25	Do.
June 8	6,600	0.35	Tetanic convulsions.
June 15	6,600	0.60	Do.
DOG 11, ADULT FEMALE.			
June 22	8,800	1	Reflexes greatly increased after 25 minutes.
June 29	8,800	1.5	Tetanic convulsions.
July 6	8,700	2	Fatal after 26 minutes.

TABLE 5.—*Dogs receiving intramuscular injections of strychnine sulphate.*

DOG 12, ADULT FEMALE.

Date.	Weight.	Dose in milligrams per kilogram.	Remarks.
	Grams.		
April 28	5,500	0.05	No appreciable effect in either pulse, respiration, or temperature. Reflexes not increased.
May 5	6,000	0.075	Do.
May 12	6,400	0.08	Do.
May 19	6,200	0.13	Reflexes increased after 15 minutes.
May 26	6,200	0.175	Convulsion after 12 minutes.
June 2	6,200	0.25	Tetanic convulsions.
June 9	6,400	0.35	Do.
June 16	6,800	0.4	Fatal after 1 hour, 24 minutes.

SUMMARY OF RESULTS [3]

From the preceding tables it is seen that:

1. In administration by mouth:
   - *a.* No appreciable effects were produced with doses as high as 0.75 milligram.
   - *b.* Hyperexcitability was produced by 0.1 to 0.25 milligram.
   - *c.* Convulsion was produced by 0.35 milligram.
   - *d.* Tetanic convulsions were produced by 0.47 to 0.8 milligram.
   - *e.* Fatal result was produced by 1 milligram.
2. In subcutaneous administration:
   - *a.* No appreciable effects were produced with doses as high as 0.075 to 0.1 milligram.
   - *b.* Hyperexcitability was produced by 0.1 to 0.175 milligram.
   - *c.* Convulsion was produced by 0.175 to 0.2 milligram.
   - *d.* Tetanic convulsions were produced by 0.25 to 0.6 milligram.
   - *e.* Fatal result was produced by 0.35 to 0.75 milligram.
3. In intravenous administration:
   - *a.* No appreciable effects were produced with doses as high as 0.05 milligram.
   - *b.* Hyperexcitability was produced by 0.075 to 0.1 milligram.
   - *c.* Convulsion was produced by 0.13 milligram.
   - *d.* Tetanic convulsions were produced by 0.175 to 0.35 milligram.
   - *e.* Fatal result was produced by 0.35 to 0.4 milligram.
4. In rectal administration:
   - *a.* No appreciable effects were produced with doses as high as 0.1 milligram.
   - *b.* Hyperexcitability was produced by 0.13 to 0.35 milligram.
   - *c.* Tetanic convulsions were produced by 0.35 to 1.5 milligrams.
   - *d.* Fatal result was produced by 1.5 to 2 milligrams.

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[3] All figures are milligrams per kilograms of body weight.

5. In intramuscular administration:
    - *a.* No appreciable effects were produced with doses as high as 0.08 milligram.
    - *b.* Hyperexcitability was produced by 0.13 milligram.
    - *c.* Convulsion was produced by 0.175 milligram.
    - *d.* Tetanic convulsions were produced by 0.25 to 0.35 milligram.
    - *e.* Fatal result was produced by 0.4 milligram.

Table 6 gives the summary of results in another form.

TABLE 6.—*Summary of results of administering strychnine to dogs.*

[NE, no appreciable effect; Hx, hyperexcitability; CE, convulsive effect; TC, tetanic convulsions; FR, fatal result.]

Dog No.	Administration.	Milligrams per kilogram of body weight.										
		0.05	0.075	0.08	0.1	0.13	0.175	0.2	0.24	0.25	0.315	0.35
1	Oral	NE	NE	------	Hx	Hx	Hx	Hx	Hx	Hx	------	CE
2	Do.	NE	NE	------	Hx	Hx	Hx	Hx	Hx	Hx	------	CE
3	Subcutaneous	NE	NE	------	Hx	Hx	CE	------	------	TC	TC	TC
4	Do.	NE	NE	NE	NE	Hx	CE	------	------	TC	TC	TC
5	Do.	------	------	------	------	------	------	------	------	CE	------	TC
6	Do.	NE	NE	------	Hx	Hx	Hx	CE	------	TC	------	FR
7	Intravenous	NE	Hx	Hx	Hx	CE	TC	TC	TC	TC	TC	TC
8	Do.	NE	Hx	Hx	Hx	CE	TC	TC	TC	TC	------	FR
9	Rectal	NE	NE	NE	NE	Hx	Hx	Hx	Hx	Hx	Hx	Hx
10	Do.	NE	NE	NE	NE	Hx	Hx	Hx	Hx	------	------	TC
11	Do.	------	------	------	------	------	------	------	------	------	------	------
12	Intramuscular	NE	NE	NE	------	Hx	CE	------	------	TC	TC	TC

Dog No.	Administration.	Milligrams per kilogram of body weight.										
		0.39	0.4	0.47	0.5	0.55	0.6	0.75	0.8	1.0	1.5	2.0
1	Oral	------	------	------	------	------	------	------	------	------	------	------
2	Do.	------	------	TC	TC	TC	TC	TC	TC	FR	------	------
3	Subcutaneous	------	------	FR	------	------	------	------	------	------	------	------
4	Do.	TC	TC	TC	TC	TC	TC	FR	------	------	------	------
5	Do.	TC	TC	TC	TC	TC	TC	FR	------	------	------	------
6	Do.	------	------	------	------	------	------	------	------	------	------	------
7	Intravenous	------	FR	------	------	------	------	------	------	------	------	------
8	Do.	------	------	------	------	------	------	------	------	------	------	------
9	Rectal	------	------	------	------	------	TC	TC	TC	TC	FR	------
10	Do.	TC	TC	TC	TC	TC	TC	------	------	------	------	------
11	Do.	------	------	------	------	------	------	------	------	------	TC	FR
12	Intramuscular	------	FR	------	------	------	------	------	------	------	------	------

At the time of the conclusion of the experiment just described, the professor of parasitology had completed some investigations pertaining to the efficiency of anthelmintics. The eight dogs utilized in his work were about to be discarded, and at my request they were placed at my disposal.

These animals were employed in an experiment having for its object the determination of the relative resistance of native dogs to strychnine and, consequently, was in a sense supplemental to the first experiment. The minimum dose which had proved fatal in the first experiment was injected subcutaneously in all the dogs. To those that did not succumb to this amount, and after the acute symptoms had subsided, an additional amount of strychnine equal to the difference between the next fatal dose (determined as before) and the one injected was administered. This procedure of administering additional strychnine sufficient to equal the next succeeding lethal dose was repeated until all the animals finally died. The results obtained are given in Table 7.

TABLE 7.—*Dogs receiving fatal doses of strychine sulphate by subcutaneous administration.*

[Amounts injected are in milligrams per kilogram of body weight.]

Dog No.	Weight.	First.	Injection.	Second.	Injection.	Third.	Injection.	Died.
	g.	*Time.*	*mg.*	*Time.*	*mg.*	*Time.*	*mg.*	*Time.*
13	8,000	10.35	0.35	2.12	0.12			2.30
14	10,250	10.54	0.35					11.14
15	8,400	10.09	0.35	2.30	0.12			2.57
16	2,400	10.00	0.35					10.17
17	6,200	10.23	0.35	1.10	0.12			1.30
18	9,200	10.05	0.35	12.40	0.12	3.03	0.13	3.18
19	11,600	10.57	0.35	1.49	0.12			2.10
20	9,600	10.15	0.35	1.04	0.12			1.30

TABLE 8.—*Summary of data in Table 7.*

Injections.				Dogs died.	
First dose.	Second dose.	Third dose.	Total.		
mg.	*mg.*	*mg.*	*mg.*	*Number.*	*P. ct.*
0.35			0.35	2	25
0.35	0.12		0.47	5	62.5
0.35	0.12	0.13	0.60	1	12.5

DISCUSSION OF RESULTS

It will be noted from the experimental results obtained that the animals were uniformly slower in showing the early effect of the drug, namely, hyperexcitability, than were those experimented upon by Sollmann.(12) On the other hand, three of them were killed by rather smaller doses. For purposes of comparison tabulated results of the present experiments and those of Sollmann are here given:

TABLE 9.—*Effects of strychnine sulphate on non-anæsthetized animals.*

[All figures are milligrams per kilogram of body weight.]

RESULTS FROM THE PRESENT EXPERIMENT.

Effect.	Mouth.	Hypodermic.	Vein.	Rectum.	Intramuscular.
No appreciable effect	0.075	0.075	0.05	0.1	0.08
Hyperexcitability	0.1	0.1	0.075	0.13	0.13
Just convulsive	0.35	0.175-0.25	0.13	---------	0.175
Just tetanic	0.47	0.25	0.175	0.35	0.25
Just fatal	1.00	0.35-0.75	0.35-0.4	1.5-2	0.4

RESULTS OBTAINED FROM SOLLMANN.

Effect.	Stomach.	Hypodermic.	Vein.	Rectum.	Other channels.
No appreciable effect	---------	0.05	---------	0.05	---------
Hyperexcitability	0.075	0.075	0.075	0.075	[a]0.08
Just convulsive	0.175	0.1-0.24	---------	0.1-0.24	---------
Just tetanic	0.47	0.25	---------	0.25	---------
Just fatal	1.2-3.9	0.35-0.75	0.4	2.00	[b]5.5

[a] Intramuscular.

[b] Bladder.

Excepting the results obtained by the oral and intramuscular modes of administration, which do not accurately check with those obtained by Sollmann,(12) the results of all other phases of the experiment are in substantial agreement with those obtained by him. In the case of the exceptions cited, the intramuscular injection of 0.08 milligram in Sollmann's work produced hyperexcitability, while in the present experiment the same dose administered by the same channel produced no appreciable effect. In administration by the mouth, 1.2 milligrams in Sollmann's experiment produced a fatal result, while in the present experiment a dose 0.2 milligram less than this amount had a similar termination. Very slight variations will be noted in the results obtained by the administration per rectum and per vein in the experiment of Sollmann and the one under consideration, as follows: In Sollmann's work 2 milligrams per rectum produced a fatal result, while in the present experiment 1.5 milligrams produced death in one animal, but another survived this amount and succumbed later to a dose of 2 milligrams, thereby agreeing with Sollmann's findings. A similar occurrence is revealed in the results obtained by intravenous injection. By this method of administration 0.4 milligram proved fatal in Sollmann's experiment. In the present experiment a dose of 0.35 milligram produced the same result in one dog, while another survived this amount and succumbed to a later administration of 0.4 milligram. It will be seen, therefore, that these differences do not furnish a wide variation and that Sollmann's findings and mine coincide substantially in all essential particulars.

The minimal lethal dose (0.75 milligram) of Kaufmann(6) calculated per kilogram of body weight is found to be 2.14 times the minimal lethal dose for subcutaneous administration (0.35 milligram) obtained in the present experiment. This finding corroborates the statements emanating from Winslow(14) and Hale,(4) based upon experimental evidence, to the effect that the fatal dose as given by Kaufmann(6) is entirely too large. The smallest therapeutic dose per kilogram fixed by Winslow, Frohner,(3) and Udall(13) is [0.0001 milligram (1/600)] and is only 28.6 per cent of the minimal lethal dose as obtained in the present experiment. But the smallest therapeutic doses for gross use given by Dun,(2) Frohner, Udall, and Brumley(1) are greater than the minimal lethal dose obtained in this experiment by 0.30, 0.58, 0.65, and 0.69 milligram, respectively. When it is considered that the toy varieties of dogs, such as the different kinds of poodles, spaniels, Pekingese, and terriers, constitute a large percentage of the canine patients encountered in practice in the Philippines, an explanation of many cases of poisoning is presented that is easily understood.

Although the different investigators are at variance as to the exact length of time required for the complete elimination of strychnine, it is at least admitted that the drug is retained in the system for some time. Udall(13) advises that when the drug is given in doses that closely approach the maximum its administration be omitted every third day. Dun(2) warns against too frequent administration of the drug; and the results of the experiment summarized in Tables 7 and 8 prove that the practice of too frequent dosing with strychnine is prolific of dangerous consequences. It may be contended that the dogs referred to above, being experimental animals, were exhausted, depressed, debilitated, and weak; but, even admitting the correctness of the contention, it is precisely in these conditions that strychnine finds its therapeutic indication.

It is a matter of general knowledge that isolated cases of increased susceptibility or individual idiosyncrasy to strychnine are fairly common, and numerous reports to substantiate this fact are on record. Winslow (14) states that "dogs appear sometimes extremely susceptible to strychnine." As remarked earlier, however, the clinical experience of many veterinarians with the administration of strychnine to dogs in the Philippines gives rise to the assumption that a hypersusceptibility or idiosyncrasy in these dogs is general and not exceptional. In order to state definitely whether such general hypersusceptibility exists or not either one or both of two proofs must be submitted: First, either an exceedingly large percentage of variation in a relatively small number of animals subjected to an experiment; or, second, a much larger number of individual cases of hypersensitiveness necessitating of course a much more extensive research into a larger number of animals.

In the present experiment the results obtained conform to those elicited by similar experiments performed in temperate countries to the extent of 75 per cent. In the variation of 25 per cent the range of difference noted was in most cases very slight. It is obvious, however, that these results cannot justify too hasty a generalization, and it is realized that the experiment was not conducted upon a scale sufficiently extensive to warrant the results being regarded as exhaustive or definitely conclusive. It is recommended, therefore, that the experiment be repeated and a more extensive research into a larger number of dogs be undertaken with the purpose of arriving at a definite solution of this rather important problem.

CONCLUSIONS

In conclusion, therefore, it must be said:

1. That a general hypersusceptibility of native dogs to strychnine has not been shown to exist by the present experiment, and
2. That the apparent hypersusceptibility reported must be explained as being due to one factor or to a combination of the following factors: (*a*) Relatively larger doses of strychnine than those given in veterinary textbooks when used in the Philippines. (*b*) Too frequent administration of the drug. (*c*) The peculiar hypersensitiveness or individual idiosyncrasy of isolated cases.

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V. NACHTRAG ZUR KENNTNIS DER PHILIPPINISCHEN RUTELIDEN (COLEOPTERA, LAMELLICORNIA)

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EINE TAFEL

Im Jahr 1910[1] gab ich eine Liste der bis dahin bekannten Rutelinen, die ich später[2] verbesserte und ergänzte. In den Jahren 1914, 1915, und 1916 gab ich weitere Nachträge;[3] seitdem sind mir wieder eine Anzahl neuer Arten zugegangen, die zum Teil von Herrn G. Boettcher, besonders aber von Herrn Prof. C. F. Baker gesammelt wurden. Eine zusammenfassende Bearbeitung der philippinischen Rutelinen verschiebe ich auf später, bis die grosse Ausbeute des Herrn G. Boettcher präpariert ist. Im Folgenden gebe ich daher nur die Beschreibung der neuen Arten.

Parastasia incurva sp. nov. Tafel 1, Fig. 1.

Der *P. femorata* Burmeister von Java zunächst verwandt, von derselben Körperform, aber meist etwas grösser und durch die grobe Punktierung des Thorax gut unterschieden. Kopf und Kopfschild sind ziemlich dicht, aber fein und seicht punktiert, der Thorax dagegen mit grossen Ringpunkten dicht bedeckt, ebenso tragen die Deckflügel Reihen grosser Ringpunkte, während das Schildchen nur wenige feine Pünktchen trägt. Die nahe verwandte *indica* Ohaus hat ganz ähnliche Färbung und ebenfalls grobe Sculptur des Thorax, aber auf den Deckflügeln feine, nach hinten verloschene Punktreihen. Der Forceps (Tafel 1, Fig. 1), ist ganz verschieden von dem der *indica*, aber ähnlich dem der *femorata*, jedoch ist das Mittelstück dicker und kürzer, die Parameren sind ganz asymmetrisch, beide mit einander verwachsen, die rechte grösser als die linke, nach hinten und links gekrümmt. Länge, 12–14 Millimeter; Breite, 6 bis 7. Männchen, Weibchen.

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[1] Philip. Journ. Sci. § D 5 (1910) 233–262.

[2] Philip. Journ. Sci. § D 7 (1912) 255–269.

[3] Stettiner Ent. Zeitg. (1914) 185–192; ibid. (1915) 339–344; ibid. (1916) 353–359.

LUZON, Kalinga, Balbalan, 30ter Januar, 1917. MASBATE, Aroroy, 17ter August, 1917 (*G. Boettcher*).

Bei dem Männchen von Masbate sind Teile des Thorax sowie die Schenkel und Hüften rotgelb, das übrige schwarz, bei dem Weibchen von Masbate nur die Hinterecken des Thorax rotgelb; Stücke von Balbalan schwarz bis rotgelb. Die Art ist vielleicht so variabel in der Färbung wie die *femorata*.

Anomala sibuyana sp. nov.

Aus der Verwandtschaft der *flavoscutellata* Ohaus von Nord-Luzon. Gestreckt eiförmig, hinten leicht verbreitert. Färbung veränderlich von scherbengelb mit schwarzbrauner Zeichnung auf Kopf, Thorax, Schildchen, Rändern der Deckflügel und Tarsen, bis schwarzbraun mit scherbengelben Rändern des Thorax, Unterseite, Schenkel und Schienen ebenfalls gelb. Clipeus trapezförmig, die Ecken wenig gerundet, fein runzelig punktiert; Kopf, Thorax, und Schildchen fein und dicht, vielfach zusammenfliessend punktiert. Auf den Deckflügeln sind die primären Punktreihen regelmässig gefurcht, die Punkte gross, ringförmig, kräftig eingedrückt, im subsuturalen Intersititium steht eine Punktreihe die in der vorderen Hälfte unregelmässig verdoppelt ist mit einigen kurzen Querrunzeln dazwischen. Pygidium dicht bedeckt mit in die Quere gezogenen Ringpunkten, die bogenförmig in die Spitze vor der Afteröffnung angeordnet sind und vielfach seitlich zusammenfliessen. After, Unterseite, und Beine mit einigen wenigen gelben Haaren. Vorderschienen mit einem deutlichen Seitenzahn. Fühlerkeule immer gelb, beim Männchen nicht verlängert. Am Forceps ist das Mittelstück lang, gewölbt, die kurzen Parameren symmetrisch, die Ventralplatte des Mittelstückes mit einem kurzen hakenförmigen Fortsatz am Hinterrand. Länge, 7.5 Millimeter. Männchen und Weibchen.

SIBUYAN (*Baker*).

Anomala melitta sp. nov.

Der A. *leotaudi* Blanchard zunächst verwandt. Vorderkörper, Deckflügel, und Beine hell scherbengelb mit braunen Flecken, glänzend, der ganze Hinterleib dunkelbraun, matt. Kopf und Vorderrücken dicht und ziemlich kräftig punktiert, der letztere mit zwei braunen Flecken auf der Scheibe. Deckflügel mit zwei unregelmässigen Querbinden von Flecken, eine an der Basis, die andere am Hinterrand; die primären Punktreihen sind tief gefurcht, Rippen und Interstitien gleich hoch gewölbt, im subsuturalen Interstitium zwei secundäre Rippen, die nahe der

Basis breiter getrennt sind, im zweiten und dritten Interstitium nur je eine seichtere Punktreihe. Bauchringe und Brust grauweis behaart. Forceps klein, ohne Besonderheiten. Länge, 10.5 Millimeter; Breite, 5.5. Männchen.

MINDANAO, Surigao, Surigao (*Baker 17041*).

Anomala surigana sp. nov. Tafel 1, Fig. 2.

Die Art steht in der Mitte zwischen *A. catenatopunctata* Ohaus und *heteroglypha* Ohaus, hat die Gestalt und Färbung der ersteren, aber eine Sculptur ähnlich derjenigen der letzteren. Erzgrün, glänzend poliert, Kopf, Thorax, und Seiten der Deckflügel hell kupferschillernd. Der Kopf ist zusammenfliessend, Stirn, Scheitel, Prothorax, und Schildchen mässig dicht einzeln punktiert, alle Punkte fein und seicht; die basale Randfurche des Thorax nicht unterbrochen; Seitengrübchen vorhanden. Auf den Elytren sind die primären Punktreihen scharf eingerissen, die Punkte deutlich ringförmig, alle einzeln; das subsuturale Interstitium enthält eine Punktreihe, die von der Basis bis zum letzten Drittel doppelt ist; die zwei discalen Interstitien enthalten je eine einfache Punktreihe; die seitlichen sind punktfrei; Schultern und Spitzenbuckel springen stark vor und sind glatt. Afterdecke sehr fein und dicht nadelrissig, wenig glänzend, nur am Rand mit einigen rötlichen Haaren. Unterseite fast kahl, nur die Brust spärlich und kurz grau behaart. An den Vorderschienen ist der Seitenzahn sehr kurz, die Mittel- und Hinterschienen sind verdickt. Der Forceps (Tafel 1, Fig. 2) ist ähnlich dem der *catenatopunctata*. Länge, 12.5 Millimeter; Breite 6.75. Männchen.

MINDANAO, Surigao, Surigao (*Baker*).

Anomala butuana sp. nov. Tafel 1, Fig. 3.

Nahe verwandt der *A. exarata* Burmeister, die nach Burmeister auch auf Luzon vorkommen soll, die ich aber nur von Celebes kenne. Gestreckt eiförmig, dunkelbraun mit erzgrünen und kupfrigen Lichtern, oben kahl, unten graugelb behaart. Der Kopf ist dicht und fein runzelig punktiert, Thorax und Schildchen mit grösseren Ringpunkten, an den Seiten dicht, in der Mitte mehr einzeln bedeckt, basale Randfurche in der Mitte breit unterbrochen. Auf den Deckflügeln sind die primären Punktreihen regelmässig gefurcht, die Punkte grob und vielfach quer eingedrückt, primäre Rippen und Interstitien respektiv secundäre Rippen gleich hoch gewölbt; im subsuturalen Interstitium stehen zwei secundäre Rippen und zwischen diesen eine tertiäre, die besonders beim Weibchen in ihrer vorderen

Hälfte abgeflacht und in eine unregelmässige Punktierung aufgelöst ist; im zweiten und dritten Interstitium stehen je zwei regelmässige secundäre Rippen; die vierte primäre Rippe aussen neben der unregelmässig punktierten vorspringenden Schulter ist in ihrem vorderen Teil verloschen, im weiteren Vorlauf nach hinten etwas verbreitert und stärker gewölbt. Afterdecke und Unterseite dicht und fein gerunzelt. Vorderschienen mit einem kräftigen Seitenzahn, Mittel- und Hinterschienen ohne Auszeichnung. Der Forceps (Tafel 1, Fig. 3) hat einige Aehnlichkeit mit dem der *A. cucusa,* doch ist bei dieser Art die Sculptur der Deckflügel eine ganz andere. Länge, 13 bis 14 Millimeter; Breite, 7 bis 7.5. Männchen und Weibchen.

MINDANAO, Agusan, Butuan (*Baker*).

Anomala volanda sp. nov. Tafel 1, Fig. 4.

Aus der Gruppe der *A. humeralis.* Kopf, Schildchen, und Halsschild schwarzbraun mit erzgrünen und kupfrigen Lichtern, lebhaft glänzend, das letztere mit einem grossen rotgelben Fleck jederseits, dicht und ziemlich kräftig punktiert. Deckflügel rotgelb mit feinem schwarzem Seitenrand, die primären Punktreihen regelmässig gefurcht, Rippen und Interstitien gleich hoch gewölbt, die drei discalen Interstitien mit je zwei secundären Rippen, im subsuturalen Interstitium zwischen den secundären Rippen von der Basis bis zur Mitte eine schmale tertiäre. Afterdecke dicht und fein runzelig, schwarzbraun mit sechs scharf begrenzten rotgelben Makeln, vier in der basalen Reihe, zwei an der Spitze. Unterseite und Beine schwarzbraun, die Mittel- und Hinterschenkel nahe dem Knie sowie die Epimeren der Mittelbrust mit einem rotgelben Fleck. Rand der Afterdecke und Brust graugelb behaart. Am Forceps tragen die Parameren an der Spitze je einen zangenartig gekrümmten asymmetrischen Fortsatz (Tafel 1, Fig. 4). Länge, 14.5 Millimeter; Breite, 8. Männchen.

MINDANAO, Surigao, Surigao (*Baker 17042*).

Anomala macrophalla sp. nov. Tafel 1, Fig. 5.

Zur Gruppe der *A. windrathi* Nonfried gehörig und in dieser der *A. camarinensis* Ohaus zunächst verwandt. Gestreckt oval, hinten nicht verbreitert, oben rotbraun, Kopf, Vorderrücken, und Schildchen mit Kupferglanz, die Nahtrippen leicht erzgrün, Unterseite und Beine schwarzbraun mit grünem Schiller, die Seiten der Bauchringe und die Afterdecke rot, die letztere mit schwarzbrauner Zeichnung; Oberseite und Afterdecke kahl, Brust und Hüften gelb behaart. Kopf, Vorderrücken, und Schildchen sind dicht und ziemlich kräftig, vielfach zusammenfliessend punktiert. Auf den Deckflügeln sind die primären Punktreihen kräftig gefurcht, die Punkte kräftig eingedrückt, dicht hintereinander stehend, halbkreis- bis kreisförmig, die primären Rippen breiter als die secundären, von letzteren in den discalen Interstitien je zwei, in den lateralen je eine stehend; die zwei secundären Rippen im subsuturalen Interstitium sind in der vorderen Hälfte getrennt dadurch, dass die Punktreihe hier sich verdoppelt mit einigen wenigen unregelmässigen Punkten dazwischen; im zweiten Interstitium ist die trennende Punktreihe zwischen den zwei secundären Rippen nur an der Basis für zwei oder drei Punkte verdoppelt. Afterdecke dicht und fein querrissig mit gröberen Runzeln an den Seiten. Bauchringe in der Mitte weitläufig, an den Seiten dichter Punktiert.

Die Forceps (Tafel 1, Fig. 5) ist ähnlich dem der *A. hamigera* Ohaus,[4] der lappenartige Fortsatz der Parameren aber noch grösser, bis zur Spitze reichend, die oberen Spitzen stärker umgebogen; die Ventralplatte des Mittelstückes mit scharfer Spitze, hakenförmig nach unten gebogen. Länge, 17 Millimeter; Breite, 8.5. Männchen.

MINDANAO, Zamboanga, Dapitan (*Baker*).

Anomala polina sp. nov.

Der *A. camarinensis* Ohaus zunächst verwandt. Gestreckt eiförmig, leicht gewölbt, dunkelbraun mit leichtem grünem Erzschimmer—bei einem ausgefärbtem Stück rotbraun—die Seiten des Halsschildes, die Deckflügel, und die Schenkel rötlich gelb. Kopfschild und Stirn sind dicht runzelig, Scheitel, Halsschild, und Schildchen ziemlich dicht aber einzeln mit grossen groben Punkten bedeckt, glänzend. Auf den Deckflügeln sind die primären Punktreihen gefurcht, Rippen und Interstitien gewölbt, im subsuturalen Interstitium zwei secundäre und dazwischen eine tertiäre Rippe, die zweite und dritte primäre Rippe tragen einzelne grobe Punkte. Afterdecke grob höckerig, nur an der Spitze und an den Seiten mit langen rotbraunen Borsten. Bauchringe und Brust sehr grob punktiert, die letztere dicht rotgelb behaart. Länge, 17 Millimeter; Breite, 10. Männchen.

LUZON, Ifugao, Mount Polis, Februar, 1917 (*G. Boettcher*).

Anomala samarensis sp. nov. Tafel 1, Fig. 6.

Der *A. camarinensis* Ohaus sehr nahe verwandt, etwas grösser, durch die Färbung and die Sculptur der Deckflügel unterschieden. Kopf, Vorderrücken, und Schildchen dunkelbraun mit erzgrünen oder kupfrigen Lichtern, Kopfschild und Seiten des Vorderrückens rotgelb, alle drei dicht und kräftig punktiert. Deckflügel rötlich scherbengelb, heller als bei der *camarinensis*, die zweite primäre Rippe (zwischen Naht und Schulter) im mittleren Drittel mit doppelter Punktreihe; im subsuturalen Interstitium steht zwischen den zwei secundären Rippen eine tertiäre, die nahe der Basis durch unregelmässige Punkte undeutlich ist. Afterdecke rotgelb mit dunklem Längsstreifen in der Mitte und einem dunklen Punkt jederseits neben der Spitze, überall sehr grob punktiert. Unterseite veränderlich, entweder rotgelb mit dunklen Flecken oder dunkel braungrün mit gelben Fleckchen an den Seiten, die Schenkel und die vorderen Schienen innen stets rotgelb. Forceps, Tafel 1, Fig. 6. Länge, 14.5 bis 15.5 Millimeter; Breite, 8 bis 8.5. Männchen und Weibchen.

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[4] Stettiner Ent. Zeitg. (1915) 127, Fig. 12.

SAMAR, Juni–Juli, 1896 (*J. Whitehead*).

Von Mindanao: Surigao, Surigao und Agusan, Butuan (*C. F. Baker*) liegt mir je ein Exemplar (No. 18550 und 18547) einer Form vor, die wohl nur als eine Localform der *A. samarensis* zu betrachten ist. Sie stimmt in allen wesentlichen Merkmalen mit dieser überein, weicht aber in der Sculptur der Deckflügel in der Weise ab, das bei dem Surigao-Stück die zweite primäre Rippe von der Basis bis zum letzten Drittel eine doppelte Punktreihe trägt, während sie bei dem Butuan-Stück fast im ganzen Verlauf glatt ist und nur im mittleren Drittel drei oder vier Punkte trägt.

Anomala cucusa sp. nov.

Aus der Verwandtschaft der *A. dapitana* Ohaus und *A. despumata* Ohaus und *A. fuscula* Sharp, grösser und breiter, die ganze Oberseite dichter und gröber punktiert und daher weniger glänzend; oben und unten erzgrün, oben kahl, Afterdecke und Brust dicht abstehend graugelb, die Bauchringe in der Mitte spärlich, an den Seiten büschelförmig behaart. Auf den Deckflügeln ist nur die Nahtrippe glatt, die sie begrenzende Punktreihe regelmässig, alle Interstitien sind dicht punktiert, die Sculptur durch feine Querrunzeln unübersichtlich. Afterdecke dicht und fein nadelrissig. Der Seitenzahn der Vorderschienen ist beinahe verloschen, die Mittel- und Hinterschienen wenig verdickt.

Der Forceps ist ähnlich dem der genannten Arten, auch dem der *A. hopei* Kirsch, *A. waterstraati* Ohaus, und *A. cobala* Ohaus, und hat an der Rutenblase (Penis) einen dichten Büschel von starren Borsten.

Länge, 14.5 bis 16 Millimeter; Breite, 8.5 bis 9. Männchen und Weibchen.

MINDANAO; Surigao, Surigao, 4ten November, 1925 (*Boettcher, Baker*).

Anomala calpurnia sp. nov. Tafel 1, Fig. 7.

Zur Gruppe der *A. chlorotica* Guérin gehörend und in dieser der *A. cassiana* Ohaus zunächst stehend. Kleiner, elliptisch, ziemlich gewölbt, Oberseite scherbengelb, der ganze Kopf, die vordere Hälfte und die Ränder des Thorax, Schildchen und Ränder der Deckflügel, Afterdecke, Unterseite, Beine, und Fühler schwarzbraun. Oberseite kahl, Afterdecke und Brust anliegend grau behaart, die Seiten der Bauchringe mit kleinen Haarbüscheln. Kopf und Halsschild mit ziemlich flachen Ringpunkten mässig dicht, Schildchen dichter und gröber punktiert. Auf den Deckflügeln sind die primären Punktreihen deutlich gefurcht, das subsuturale Interstitium mit unregelmässigen Punktreihen, die zweite primäre Rippe zum Teil mit gereihten Punkten, zum Teil punktfrei, das zweite und dritte Interstitium mit je zwei Punktreihen, die dritte primäre Rippe punktfrei. Unterseite und Beine wie bei der *A. cassiana;* der Forceps (Tafel 1, Fig. 7) ist kleiner, die Parameren gleich gross.

Länge, 11 Millimeter; Breite, 6. Männchen.

POLILLO, bei LUZON (*Baker*).

Anomala cassiana sp. nov. Tafel 1, Fig. 8.

Der *A. chlorotica* Guérin zunächst verwandt. Gestreckt elliptisch, mässig gewölbt. Oben leicht rötlich scherbengelb ohne allen Metallschiller, Schultern und feiner Saum der Deckflügel dunkelbraun; Unterseite und Afterdecke, Beine und Fühler kastanienbraun. Oberseite kahl, Bauch und Beine spärlich, Afterdecke und Brust dicht und anliegend graugelb behaart, die Seiten der Bauchringe mit Haarbüscheln. Kopfschild sehr kurz, fast dreimal so breit als lang, mit ziemlich stark gerundeten Vorderecken, die Fläche wie die Stirn dicht mit zusammenfliessenden Ringpunkten bedeckt. Auf dem Halsschild sind diese Ringpunkten etwas grösser, an den Seiten dicht zusammenfliessend, auf der Scheibe nur wenig sperriger; die Basale Randfurche ist nicht unterbrochen. Schildchen wie Halsschild punktiert. Auf den Deckflügeln sind die primären Rippen nicht gewölbt, von den primären Punktreihen ist nur die erste, neben der Nahtrippe, ganz erhalten, von der zweiten bis sechsten nur kurze Reste nahe dem Hinterrand erhalten, alles übrige ist mit unregelmässigen, dichten Punktreihen bedeckt; im subsuturalen Interstitium etwa sechs, nur die Seiten sind wie gewöhnlich etwas weniger punktiert. Vorderschienen mit kurzen Spitzenzahn, beide Seitenzähne verloschen; Mittel- und Hinterschienen leicht verdickt, ganz ohne schiefe Stachelkanten. Der Forceps (Tafel 1, Fig. 8) ist ähnlich dem der *A. brachycaula* von Celebes, die rechte Paramera grösser als die linke. Länge, 12.5 Millimeter; Breite, 6.5. Männchen.

MINDANAO, Zamboanga, Dapitan (*Baker*).

Anomala metella sp. nov. Tafel 1, Fig. 9.

Der *A. cuprascens* Wiedemann von Java und Sumatra zunächst verwandt, von derselben Körperform, Grösse, und Färbung, aber verschieden durch die Sculptur der Deckflügel. Wie auf Kopf, Thorax, und Schildchen ist auch auf den Elytren die Punktierung feiner und seichter als bei der *cuprascens*, die primären Punktreihen sind nicht gefurcht, die primären Rippen nicht höher als die Interstitien, ganz punktfrei; das subsuturale Interstitium ist unregelmässig punktiert bis zum Hinterrand, im zweiten Interstitium steht eine einfache, nur vorn und hinten kurz verdoppelte Punktreihe. Propygidium und Pygidium sind dicht und fein querrissig, Unterseite und Beine wie bei der *cuprascens*, die Fühlerkeule etwas länger. Forceps, Tafel 1, Fig. 9. Länge, 14 Millimeter; Breite, 7.5. Männchen.

BORNEO, Sandakan (*Baker*).

Malaia stigma sp. nov.

Der *M. thoracica* Ohaus ähnlich. Kopf, Vorderrücken, und Schildchen erzgrün, dicht und fein runzelig punktiert, stellenweise nadelrissig, wenig glänzend; die Stirn dreiseitig abgeflacht; Thorax ohne Seitengrübchen, ohne basale Randfurche, ohne glatte Schwiele beim Hinterrand. Deckflügel abgeflacht mit stark vorspringenden Schultern und flachen Spitzenbuckeln, die primären Punktreihen scharf gefurcht, die Punkte gross, ringförmig; die Grundfarbe ist entweder rein hell rotbraun, oder rotbraun mit schwarzbraunem breitem Seitenrand und braunem Fleckchen direkt hinter dem Schildchen und nahe dem Hinterrand; im subsuturalen Interstitium steht auf der inneren secundären Rippe ein kleines hellgelbes Fleckchen. Die ganze Oberseite ist kahl, die hintere Hälfte des Propygidium, das Pygidium ganz, der Leib und die Brust dicht mit gelben Schuppenhaaren bekleidet. An Vorder- und Mittelbeinen sind Schenkel und Schienen, an den Hinterbeinen nur die Schenkel hellgelb mit grünem Erzschiller, die Hinterschienen und alle

Tarsen dunkel erzgrün. Fühler schwarzbraun mit hellerer Geissel.

Der Forceps ist ähnlich dem der *Pseudomalaia flavopilosa* Ohaus von Negros, welche Art den Uebergang zwischen *Malaia* und *Popillia* bildet. Länge, 8 bis 8.5 Millimeter; Breite, 4.5 bis 5.

MINDANAO, Surigao, Surigao (*Boettcher, Baker*).

Popillia nona sp. nov. Tafel 1, Fig. 10.

Der *P. depressa* Kraatz zunächst verwandt, von derselben Körperform und Grösse. Kopf und Kopfschild hell erzgrün, glänzend, dicht und kräftig runzelig punktiert. Thorax hell bräunlichgelb mit einer grossen dunkeln Makel, erzgrün schillernd, mit grossen zusammenfliessenden Ringpunkten dicht bedeckt. Schildchen braungelb mit dunklem Rand, dicht grob punktiert. Deckflügel bräunlichgelb mit dunklem Seitenrand und Schultermakel, an der Basis und hinter dem Schildchen mit kleiner weissgelber Makel, die primären Punktreihen ganz seicht gefurcht. Afterdecke mit seichten weitläufigen Querrissen und grossen gelblichen Haarbüscheln, die an der Basis zusammenstossen. Unterseite dicht gelblich behaart. Beine bräunlichgelb mit schwarzbraunen Tarsen. Forceps, Tafel 1, Fig. 10. Länge, 7 bis 7.5 Millimeter; Breite, 4. Männchen and Weibchen.

MINDANAO, Surigao, Surigao (*Baker 17038*).

Popillia alticola sp. nov.

Der *P. conopyga* Ohaus zunächst verwandt, kleiner. Oval, abgeflacht, entweder rein dunkelblau oder die Deckflügel mit rötlichgelber Scheibe, mässig glänzend. Kopf und Vorderrücken dicht und grob, vielfach zusammenfliessend punktiert, der letztere ohne Seitengrübchen, ohne basale Randfurche, mit scharf ausgezogenen Ecken, nach innen vom Ort des Seitengrübchens flach vertieft, der Seitenrand mit längeren gelben oder weissen Haaren, die an den Ecken kurz auf Vorder- und Hinterrand übergehen. Schildchen mit wenigen seichten Punkten. Die Deckflügel sind auf der Scheibe hinter dem Schildchen tief eingedrückt, die Schultern springen kräftig, die Spitzenbuckel weniger vor, die primären Punktreihen sind tief gefurcht. Afterdecke breit gewölbt, mit einzelnen groben Ringpunkten, an der Basis zwei grosse Haarbüschel und ausserdem der Seitenrand mit langen Haaren, die vor den Ecken der Afteröffnung zu kleineren Büscheln verdichtet sind. Bauchringe mit langen Haaren, die vom Vorderrand entspringen; Brust, Hüften, und Schenkel ziemlich dicht behaart. Klauenglied gezähnt, die grössere Klaue an allen Füssen lang. Der Forceps ist stark verschieden von dem der *conopyga*. Länge, 7.5 bis 8 Millimeter; Breite, 4.5. Männchen.

LUZON, Nueva Vizcaya, Imugan, Juni, 1916 (*Boettcher*): Benguet, Baguio (*Baker*).

Adoretus speculator sp. nov.

Zur Gruppe des *A. luridus* Blanchard gehörend. Gestreckt parallel, flach gewölbt, oben ziemlich dunkel rotbraun, Kopfschild und Elytren sowie die Unterseite und Beine etwas heller, überall gleichmässig sperrig fein graugelb behaart. Der Kopf ist sehr gross, besonders die Augen, Stirn und Scheitel länger als der Clipeus, dessen parabolischer Rand kräftig aufgebogen ist. An der Oberlippe ist das Rostrum lang, schmal, glänzend schwarz, kaum gekerbt. Thorax wohl dreimal so breit als lang, wie der Kopf einzeln seicht punktiert. Auf den Elytren sind die primären Punktreihen gefurcht, die Punkte kräftig, dichtstehend, die Interstitien feiner punktiert. Afterdecke länger abstehend gelb behaart. An den Vorderschienen stehen die drei spitzen Zähne in gleichem Abstand, Mittel- und Hinterschienen haben nur je eine lange schiefe Stachelkante. Fühlerkeule fast so lang als die Geissel. Länge, 9 Millimeter; Breite, 5. Männchen.

BORNEO, Sandakan (*Baker*).

Chaetadoretus bakeri sp. nov.

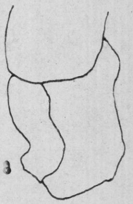
Dem *C. trichostigma* Ohaus von Nord Borneo zunächst verwandt, aber in folgenden Punkten verschieden. Etwas grösser, hell scherbengelb, leicht glänzend, sperrig weiss behaart mit zwei bräunlichen Flecken auf dem Thorax. Clipeus rötlichgelb, fein und spärlich punktiert, Stirn und Scheitel gröber und dichter. Auf den Deckflügeln sind alle primären Rippen deutlich ausgeprägt und höher gewölbt als die Interstitien, die Spitzenbuckel vorspringend, glatt, gelblich, die Partie dahinter bräunlich, nur mit einem kleinen Büschel weisser Haare, nicht mit einer Querbinde, wie bei der *C. trichostigma*. An den Vorderschienen sind die Zähne kräftig, schwarzbraun, der mittlere dem Spitzenzahn genähert. Mittel- und Hinterschienen verbreitert und verdickt, die basale der beiden Stachelkanten fast verloschen. Am Forceps sind die Parameren in zwei ziemlich lange braune Spitzen ausgezogen. Länge, 11 Millimeter; Breite, 6. Männchen.

BASILAN (*Baker*).

TAFELERKLÄRUNG

TAFEL 1. FORCEPS DER RUTELIDEN

FIG. 1. *Parastasia incurva* sp. nov.
2. *Anomala surigana* sp. nov.
3. *Anomala butuana* sp. nov.
4. *Anomala volanda* sp. nov.
5. *Anomala macrophalla* sp. nov.
6. *Anomala samarensis* sp. nov.
7. *Anomala calpurnia* sp. nov.
8. *Anomala cassiana* sp. nov.
9. *Anomala metella* sp. nov.
10. *Popillia nona* sp. nov.



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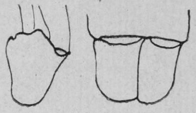

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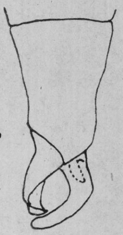

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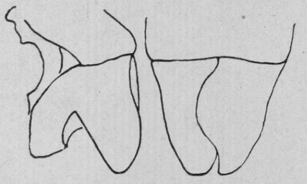

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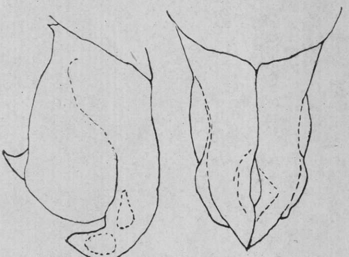

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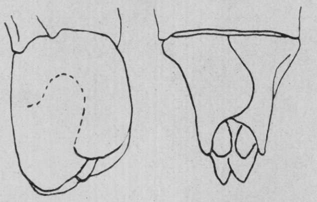

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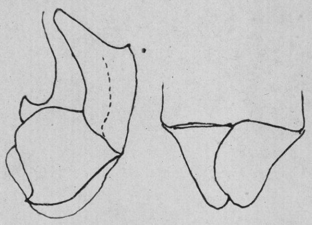

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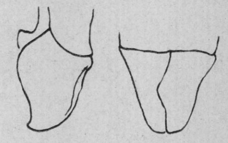

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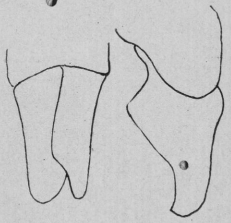

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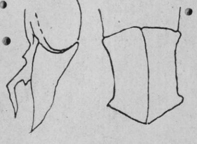

10

TAFEL 1.

NEW MALAYAN WASPS OF THE SUBFAMILY PSENINÆ

By S. A. Rohwer

Honorary Custodian of Hymenoptera, United States National Museum

In a recent paper[1] I described fourteen species of psenid wasps from the Philippines. Since that paper was prepared, Prof. C. F. Baker has forwarded other species of the subfamily Pseninæ; most of these were undescribed, and many of them came from the Philippines. With the descriptions here presented the number of Philippine species of this subfamily totals twenty-one, a very creditable number considering the area of the Islands. More collecting will, however, undoubtedly produce additional undescribed forms, and field observations will aid greatly in associating sexes.

Genus **DIODONTUS** Curtis

The following three new species run to couplet 6 in my key[2] and may be separated as follows:

6. Petiole longer than hind femora, concolorous with gaster; area outside lateral ocelli depressed.................. **D. philippinensis** Rohwer.

Petiole subequal in length with hind femora, concolorous with gaster; area around ocelli not depressed; no transverse carina on face. **D. penangensis** sp. nov.

Petiole black; area around ocelli not depressed; a transverse carina below antennæ.................. 6^{a}.

6^{a}. Petiole not sharply separated from rest of tergite; inclosure of propodeum longer and with strong carinæ; face narrower. **D. dapitanensis** sp. nov.

Petiole sharply separated from rest of tergite; propodeal inclosure shorter and with close carinæ; face broader.................. 6^{b}.

6^{b}. Antenna slender, the joints not rounded out; face not strongly narrowing; propodeum beyond inclosure punctured. **D. basilanensis** Rohwer.

Antenna with joints rounded out; eyes strongly converging below; dorsal part of propodeum smooth.................. **D. antennatus** sp. nov.

Diodontus penangensis sp. nov.

Female.—Length, 6.5 millimeters. Clypeus convex, the anterior margin bidentate medianly; face closely punctured, convex at end of frontal carina but without a transverse carina; eyes closest together just below antennæ; frons with close distinct punctures; vertex with widely scattered punctures; ocelli in an obtuse triangle; postocellar line subequal with ocellocular; antennæ short, stout, distinctly thickening apically, third joint somewhat longer than fourth; pronotum strongly carinate anteriorly, the lateral angles rounded; scutum shining, very sparsely punctured; notauli indicated on anterior half of scutum; suture in front of scutellum feebly foveolate; scutellum shining with a few punctures; dorsal area of propodeum shining, with a wide depressed area medianly which connects posteriorly with the deep channel and anteriorly with the nearly linear, foveolate basal area; posterior face of propodeum coarsely reticulate, the sides nearly smooth; mesepisternum polished, the suture strongly foveolate; petiole strongly curved, cylindrical, subequal in length with hind femora, distinctly separated from rest of tergite; gaster polished; first recurrent received near base of second cubital cell; second recurrent sinuate, joining third cubital cell a distance equal to about half the length of second intercubitus from base of cell; second cubital cell about three times as long on cubitus as on radius. Black; scape, basal joints of antennæ, and flagellum beneath rufopiceous; tubercules and tegulæ testaceous; abdomen dark rufous; tibiæ and tarsi testaceous; head and thorax with dense silvery hair; wings hyaline, venation dark brown.

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[1] Philip. Journ. Sci. 18 (1921) 309. Separates received in Washington, August 4, 1921.

[2] Philip. Journ. Sci. 18 (1921) 310.

Type locality.—Penang Island.

Described from one female received from C. F. Baker.

Type.—Catalogue No. 25037, United States National Museum.

Diodontus dapitanensis sp. nov.

Female.—Length, 9 millimeters. Clypeus very gently convex, the anterior margin truncate; face finely coriaceous, with an incomplete transverse ridge, which medianly joins frontal carina; eyes closest together opposite antennæ, the area between eyes narrow; frons and vertex polished; lateral ocelli in pits; ocelli in an obtuse triangle; postocellar line shorter than ocellocular line; antennæ extending a little beyond hind margin of tegulæ, thickening apically, third joint longer than fourth; anterior margin of pronotum sharp, the lateral angles sharp; scutum shining, with well-separated punctures; notauli evident for about three-fourths the length of scutum; suture in front of scutellum not foveolate; scutellum shining, with sparse setigerous punctures; metanotum hairy; dorsal area of propodeum polished, the inclosure triangular and with strong rugæ; posterior face of propodeum coarsely reticulate, the channel deep and foveolate; mesepisternum polished, the suture foveolate; sides of propodeum coarsely reticulate; petiole cylindrical, strongly curved basally, not sharply separated from rest of tergite; gaster polished; pygidium not defined, pygidial area finely granular; first recurrent received very close to end of first cubital cell; second recurrent sinuate, received by third cubital a distance about equal to one-third the length of second intercubitus from base of cell; second cubital cell about twice as long on cubitus as on radius. Black; mandibles, scape, tubercules, legs, and base of petiole yellowish; tegulæ and flagellum (except above) testaceous; central area of first tergite black; apex of first tergite and all of following segments rufous; head and thorax with dense silvery hair; wings hyaline, venation testaceous.

Type locality.—Dapitan, Mindanao.

Described from one female received from C. F. Baker.

Type.—Catalogue No. 25038, United States National Museum.

Diodontus basilanensis Rohwer.

A female from Sandakan, Borneo, agrees with the type and is returned to the sender, C. F. Baker. A male collected at Singapore certainly belongs to this species and agrees well with the description of the female.

Diodontus antennatus sp. nov.

Male.—Length, 7 millimeters. Anterior margin of clypeus bidentate medianly; face finely coriaceous; transverse carina incomplete and where it joins frontal carina arched dorsally; eyes closest together opposite antennæ; frons shining, with well-separated, distinct punctures; vertex with the punctures more widely separated; area around ocelli not depressed; ocelli in a low triangle; postocellar line as long as ocellocular; antennæ long, moniliform, third joint longer than fourth; anterior margin of pronotum sharply carinate and slightly dentate laterally; scutum shining, very sparsely punctured; notauli indicated anteriorly; suture in front of scutellum foveolate; scutellum shining; metanotum hairy; dorsal area of propodeum polished, depressed medianly, the depression connecting anteriorly with the linear foveolate inclosure and posteriorly with the deep channel; posterior face of propodeum coarsely reticulate; mesepisternum shining, with scattered setigerous punctures, the suture foveolate; sides of propodeum shining; petiole cylindrical, strongly curved, subequal in length with hind femur, distinctly separated from rest of tergite; gaster polished; first recurrent received by second cubital close to base; second recurrent sinuate below, received by third cubital a distance about equal to half the length of second intercubitus from base of cell; second cubital cell more than twice as long on cubitus as on radius. Black; scape, flagellum beneath, tubercules, and tegulæ testaceous; trochanters, four anterior femora above, all tibiæ and tarsi yellowish with some brownish infuscations; gaster rufous; head and thorax with usual silvery hair; wings hyaline, venation dark brown.

Type locality.—Singapore, Straits Settlements.

Described from one male received from C. F. Baker.

Type.—Catalogue No. 25039, United States National Museum.

Diodontus scutatus Rohwer.

In the material examined are two new color varieties of this species which may be distinguished by the following key:

1. Mesepisternum and sternum entirely pale; gaster ferruginous; scutum mostly pale .... **D. scutatus** var. **scutatus** Rohwer.
   Mesepisternum mostly and sternum entirely black .... 2.
2. Mesepisternum with a yellow line below; anterior part of scutum yellow; gaster rufous .... **D. scutatus** var. **mindanaoensis** var. nov.
   Mesepisternum entirely black; anterior part of scutum black; gaster piceous .... **D. scutatus** var. **borneensis** var. nov.

Diodontus scutatus var. **borneensis** var. nov.

Female.—Length, 7.5 millimeters. Because of the dark gaster this superficially resembles *Diodontus xanthognathus* Rohwer, but it differs markedly from that species. The scutum, except a quadrate spot before the scutellum and the narrow lateral margins, is black. Mesepisternum (except spot below tegula) and sternum black; metapleura black; gaster piceous; otherwise colored like the typical form.

Type locality.—Sandakan, Borneo.

Described from one female received from C. F. Baker.

Type.—Catalogue No. 25040, United States National Museum.

Diodontus scutatus var. **mindanaoensis** var. nov.

Female.—Length, 8.5 millimeters. Differs from the type in the following color characters: Black spot on the scutum larger, covering most of the surface; base and apex of propodeum black; mesepisternum, except prepectus and a narrow longitudinal ventral line, and mesosternum black; metapleuron black.

Type locality.—Iligan, Mindanao.

Described from a single female received from C. F. Baker.

Type.—Catalogue No. 25041, United States National Museum. This may possibly be the female of variety A.

Diodontus bakeri Rohwer.

A female from Iligan, Mindanao, has been examined and returned to the sender, C. F. Baker.

Diodontus ajax Rohwer.

A female from Singapore forwarded by C. F. Baker is smaller than the type (length 9.5 millimeters), has the black of the thorax more extensive, and has the petiole rufous.

The following five species, known only from the male, run to *D. ajax* Rohwer in my key.[3] None of them agree with any of the females examined and until the antigeny of this group is better understood they would best be given separate names. They may be separated as follows:

1. Posterior face of propodeum smooth, without sculpture; scutum yellow, with a single black spot .... **D. sandakanensis** sp. nov.
Posterior face of propodeum coarsely sculptured; scutum with at least three black spots .... 2.
2. Flagellar joints cylindrical, not rounded out beneath.
D. filicornis sp. nov.,
Flagellar joints 5 to 12 rounded out beneath .... 3.
3. First recurrent received in second cubital cell; scutum with three black spots .... **D. davanus** sp. nov.
First recurrent received in first cubital cell; scutum with three black lines .... 4.
4. Third and fourth antennal joints subequal; petiole unicolorous.
D. ajaxellus sp. nov.
Third joint distinctly longer than fourth; apex of petiole black.
D. esuchus sp. nov.

Diodontus sandakanensis sp. nov.

Evidently closely allied to *Diodontus interstitialis* (Cameron). It differs from the description of *Psen lutescens* Turner, which is said to be a synonym, in having the first recurrent received near apex of first cubital cell and in having the base of petiole yellow.

Male.—Length, 5.5 millimeters. Clypeus convex, the apical margin with two small median teeth; face shining, with close setigerous punctures; the transverse ridge below antennæ rounded laterally and joining antennal fossæ; frons smooth; ocelli in a low triangle; postocellar line much shorter than ocellocular line; antennæ slender, third joint longer than fourth, joints 5 to 12 slightly rounded out beneath; thorax smooth; suture in front of scutellum finely foveolate; propodeal inclosure broadly triangular in outline, with ten slightly oblique rugæ, the median ones somewhat stronger; second cubital cell twice as long on cubitus as on radius; first recurrent received near apex of first cubital cell; petiole shorter than hind femora, slightly wider posteriorly; abdomen smooth and shining. Yellow; head except mandibles, flagellum except basal joints beneath, a small spot in center of scutum, suture in front of scutellum, inclosure of propodeum, prepectus, sternum, metapleuron, and apex of petiole black; abdomen beyond petiole rufous; wings hyaline; venation pale brown; head with silvery hair.

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[3] Philip. Journ. Sci. 18 (1921) 310.

Type locality.—Sandakan, Borneo.

Described from one male received from C. F. Baker under his number 16829.

Type.—Catalogue No. 25042, United States National Museum.

Diodontus filicornis sp. nov.

Readily separated from its allies by the cylindrical joints of the flagellum.

Male.—Length, 7.5 millimeters. Anterior margin of clypeus with two small teeth medianly; transverse carina below antennæ strong and joining the equally strong frontal carina; eyes converging toward clypeus; frons and vertex shining; ocelli in a low triangle, the anterior ocellus in a shallow depression; postocellar line subequal with ocellocular line; antennæ as long as head and thorax, the joints cylindrical, not produced beneath, third joint somewhat longer than fourth; anterior margin of pronotum carinate, lateral anterior angles rounded; scutum polished, but with a few distinct punctures; notauli wanting; suture in front of scutellum finely foveolate; dorsal surface of propodeum polished, basal area rectangular in outline and with strong rugæ; median channel of propodeum deep; posterior face of propodeum coarsely reticulate; mesepisternum polished, the suture not foveolate; petiole gently curved, cylindrical, subequal with hind femur, well separated from rest of tergite; first recurrent received by first cubital a short distance before apex; second recurrent gently bisinuate, received by third cubital cell a distance somewhat greater than half the length of second intercubitus from its base; second cubital about one-third longer below. Head and thorax black; mandibles (except apices) and scape yellow; flagellum brown, testaceous at base beneath; dorsal part of pronotum, scutum except three black elongate spots, scutellum, metanotum, posterior face of propodeum (except median furrow), two spots below anterior wing and one below posterior wing yellow; base of petiole yellowish, apex black; gaster rufous; four anterior legs and posterior coxæ yellowish;

hind legs beyond coxæ testaceous; head with the usual silvery pubescence; wings hyaline, venation pale brown.

Type locality.—Basilan Island.

Described from one male received from C. F. Baker under his number 16826.

Type.—Catalogue No. 25043, United States National Museum.

Diodontus davanus sp. nov.

Very like *Diodontus luzonensis* Rohwer, but that species lacks the transverse ridge below the antennæ.

Male.—Length, 7 millimeters. Anterior margin of clypeus produced medianly into a low, rather narrow, emarginate process; transverse ridge below antennæ strong, gently curved laterally and medianly joining the equally prominent frontal ridge; inner margins of eyes converging toward clypeus but closer together opposite insertion of antennæ; frons and vertex shining; ocelli in a low triangle; postocellar line subequal with ocellocular line; antennæ nearly as long as head and thorax, joints 7 to 12 rounded out beneath, joints 3 and 4 subequal; pronotum strongly carinate anteriorly, lateral anterior angles rounded; scutum shining, with a few well-separated punctures; notauli present on about anterior half; suture in front of scutellum foveolate; dorsal surface of propodeum polished, the basal area triangular in outline and with strong rugæ which are well separated medianly; median channel deep and well defined; posterior face of propodeum coarsely reticulate; mesepisternum polished, the suture not foveolate; petiole evenly curved, cylindrical, subequal in length with hind femur and well separated from rest of tergite; gaster polished; first recurrent received in second cubital very close to first intercubitus; second recurrent bisinuate, received in third cubital cell a distance slightly less than half the length of second intercubitus from base of cell; second cubital cell one-third longer below. Head black, mandibles and scape yellow; flagellum brownish above, testaceous beneath; thorax yellow; anterior part of pronotum, spot below tegula, posterior part of mesepisternum, metapleura, three spots on scutum, narrow line before scutellum, and base of propodeum as well as propodeal furrow black; base of petiole yellowish, its apex brownish; gaster rufous; legs rufous-testaceous; head with usual silvery hair; wings hyaline, venation brown.

Type locality.—Davao, Mindanao.

Described from one male received from C. F. Baker.

Type.—Catalogue No. 25044, United States National Museum.

Diodontus ajaxellus sp. nov.

Apparently somewhat like *Psen ornatus* Ritsema but differs in some color markings and in venation.

Male.—Length, 7 millimeters. Slender. Anterior margin of clypeus with two small, triangularly shaped teeth medianly; transverse ridge below antennæ strong, and joining the equally strong frontal ridge medianly; frons and vertex shining; ocelli in nearly an equilateral triangle; postocellar line slightly less than ocellocular line; antennæ as long as head and thorax, joints 6 to 12 rounded out beneath, third joint subequal with fourth; pronotum carinate anteriorly, lateral anterior angles sharp but not dentate; scutum polished and with a few punctures; notauli indicated anteriorly; dorsal surface of propodeum polished, basal area triangular in outline and crossed by strong rugæ which are more widely separated medianly; posterior face of propodeum coarsely reticulate, the median channel deep; mesepisternum polished, the suture foveolate; petiole gently curved, cylindrical, fully as long as hind femur, not very sharply separated from rest of tergite; gaster polished; first recurrent received by first cubital cell close to first intercubitus; second recurrent bisinuate, received by third cubital a distance equal to half the length of second intercubitus from base of cell; second intercubitus perpendicular; second cubital cell one-third longer below. Head and thorax black; mandibles and scape yellow; flagellum, from the basal joints, testaceous beneath; dorsal part of pronotum, three spots on mesepisternum (the lower one smallest), spot below hind wings, scutum except three broad lines, scutellum, metanotum, and posterior face of propodeum (except median channel) yellow; four anterior legs and hind coxæ yellow; hind legs below coxæ testaceous; abdomen rufous, base of petiole yellowish; head with the usual pale pubescence; wings hyaline, venation pale brown.

Type locality.—Kolambugan, Mindanao.

Described from one male received from C. F. Baker.

Type.—Catalogue No. 25045, United States National Museum.

Diodontus esuchus sp. nov.

Male.—Length, 8 millimeters. Close to *Diodontus ajaxellus* sp. nov., from which it differs as follows: More robust; third antennal joint distinctly longer than fourth; petiole strongly curved; first recurrent received by first cubital a distance equal to about one-third the length of first intercubitus from end of cell; second cubital cell about one-fourth longer below (due to the nearly perpendicular first intercubitus); four anterior femora brownish beneath; hind legs brownish with tarsi black; apex of petiole black.

Type locality.—Sandakan, Borneo.

Described from one male received from C. F. Baker under his number 16828.

Type.—Catalogue No. 25046, United States National Museum.

Diodontus xanthognathus Rohwer.

The following specimens submitted by C. F. Baker have been examined: Female, from Singapore, Straits Settlements (*Baker 16830*); female, from Penang Island; male, from Sandakan, Borneo (*Baker 16827*); male, from Tangcolan, Bukidnon, Mindanao.

Psen (Mimesa) bakeri sp. nov.

Very like *Psen* (*Mimesa*) *politiventris* Rohwer, but it differs as follows and can hardly be the male of that species:

Male.—Length, 10.5 millimeters. Produced part of clypeus without a median emargination; pubescence of face silvery; petiole bicarinate laterally; scutum rather closely striate-punctate; scutellum more coarsely punctured and with a tendency to striate puncturation; propodeal inclosure flat, shining, without a median channel but with ten rugæ; second recurrent a short distance beyond second intercubitus; wings hyaline. Antennæ longer than head and thorax, third joint distinctly longer than fourth, flagellar joints 6 to 9 slightly constricted at base and apex beneath.

Type locality.—Haight's Place (Pauai), in mountains near Baguio, Mountain Province, Luzon. Altitude about 2,500 meters.

Described from one male (*Baker 16825*).

Type.—Catalogue No. 25047, United States National Museum.

A DISEASE OF SATSUMA AND MANDARIN ORANGE FRUITS CAUSED BY GLOEOSPORIUM FOLIICOLUM NISHIDA

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ONE PLATE AND ONE TEXT FIGURE

OCCURRENCE AND DISTRIBUTION

The Unshiu oranges, *Citrus nobilis* var. *unshiu*, are loose-skinned fruits closely related to the mandarin oranges and are the most commonly grown citrus fruits in Japan. Until recently the Unshiu oranges were not grown commonly elsewhere than in Japan, but in the last twenty years these varieties have been grown in the Gulf States of the United States rather extensively although they are known there as Satsuma oranges. According to Tanaka(10) there are six strains, or perhaps they may be called varieties, of the Unshiu oranges; Owari, Zairai, Ikiriki, Ikeda, Hira, and Wase.

In September, 1919, a disease was observed upon fruits of the Wase Unshiu orange, at Saigo, Nagasaki Prefecture, Japan. In the orchard where it was first observed only two trees showed the disease, the fruits of those two trees, however, showing at least 20 per cent of the fruits affected. At Saigo, this was the first season that the disease had been observed. The disease was next observed in the Arita River Valley, Wakayama Prefecture. Two trees only of the Wase Unshiu variety were observed, but one fruit upon one of these trees showed a typical case of the Wase rot. The owner of the trees stated that he had observed this trouble the previous year, but that this year it was not so serious. He had not seen the disease before that time. At Tsukumi, Oita Prefecture, the disease was again observed. The Wase Unshiu variety is being planted rather extensively in this place, and the disease was correspondingly prevalent. One orchard was seen in which the fruits were entirely unharvested as yet. In this orchard the number of affected fruits was conservatively 10 per cent of the total crop.

The Wase Unshiu variety is also planted commercially at Ocho, Hiroshima Ken. The disease was observed at this place also, although at the time of the observation most of the fruits were harvested and no estimate of the injury due to the disease could be made. The disease was said to have been first seen two years before and at that time was very serious; during the present year (1919) it was not so injurious.

DESCRIPTION OF THE DISEASE

The disease has so far been observed only upon the Wase Unshiu variety in the field; it has not yet been observed occurring naturally upon any of the other varieties of the Unshiu oranges or upon any of the other *Citrus* species. The disease is very peculiar in this respect in that in nature in Japan it seems to be limited to a single horticultural variety, while closely related varieties are not at all affected.

The disease has so far been observed affecting only the fruits. The skin of the fruit becomes a brown color; the spot spreads quickly, the center of the spot becoming lighter and grayish in color, while the advancing edges of the spot remain dark brown or even become dead black. The spot is slightly depressed and a very definite line of demarcation exists between the diseased spot and the normal skin. The size and the shape of the spots vary; a spot may be as small as 2 to 3 millimeters in extent in its longest diameter while the largest spot observed was 50 millimeters in its longest diameter. The longest diameter is typically in a lateral direction as shown in Plate 1. As the disease advances small black pustules can be seen forming in large numbers in the grayish center of the lesion; these are the acervuli of the causal fungus and contain the spores of the fungus in large numbers. The spots appear typically near the blossom end of the fruit, usually just to one side of the navel, never at the navel. The spots have never been observed as yet to occur near the stem end of the fruit.

The injury to the fruits is at first confined largely to the skin and does not extend into the flesh of the fruit. In the early stages of the disease, therefore, although the skin may be blackened, giving to the fruit the appearance of being badly rotted, it will nevertheless be intact within and perfectly edible. With the advance of the disease, other fungi intrude which spread into the flesh of the fruit more readily, and the fruit becomes spoiled for use and quickly rots. The fruits, moreover, when once affected, quickly drop to the ground and there rotting of the fallen fruits proceeds more rapidly. As a general thing fruits affected with this disease are a total loss to the grower. The colored photograph, Plate 1, probably gives a better idea of the disease than does the written description. This disease has been called in the field Wase Unshiu rot, because the disease in nature has been confined to the Wase Unshiu variety and the word rot is fairly descriptive of the trouble. Probably, for the use of pathologists, the term anthracnose of Unshiu oranges would be more descriptive.

THE CAUSE OF THE DISEASE

Attempts at isolation of a causal fungus were first made with fruits obtained at Saigo. The isolation attempts resulted uniformly, a fungus of the genus *Gloeosporium* being obtained in every planting in each plate. This fungus was maintained in pure culture and inoculated into perfectly healthy fruits of the Wase Unshiu orange. The inoculation data and results are given in Table 1.

TABLE 1.—*Showing results of inoculation experiments to reproduce Wase rot on ripe Wase Unshiu orange fruits. Inoculations made with needle punctures in fruits in moist chambers at laboratory temperatures, 26 to 30° C., on October 2, 1919; results observed October 21, 1919.*

No. of inoculated fruit.	Inoculum.	Result.	No. of inoculated fruit.	Inoculum.	Result.
1	Tap water	Negative.	19	Infusion of *Gloeosporium* species.	Positive.
2	do	Do.	20	do	Negative.
3	do	Do.	21	do	Do.
4	do	Do.	22	do	Positive.
5	do	Do.	23	do	Do.
6	do	Do.	24	do	Do.
7	do	Do.	25	do	Do.
8	do	Do.	26	do	Do.
9	do	Do.	27	do	Do.
10	do	Do.	28	do	Do.
11	do	Do.	29	do	Negative.
12	do	Do.	30	do	Positive.
13	Infusion of *Gloeosporium* species.	Do.	31	do	Do.
14	do	Do.	32	do	Do.
15	do	Do.	33	do	Do.
16	do	Do.	34	do	Negative.
17	do	Do.	35	do	Do.
18	do	Do.	36	do	Do.

Table 1 shows the control inoculations to have remained entirely healthy, while the inoculations with the fungus infusion produced twelve cases of the disease from a total of twenty-four attempts. That is, 50 per cent of the inoculations with the fungus resulted in positive cases of the disease.

The inoculations were then repeated upon fruits still remaining on the tree under orchard conditions. Of thirty such inoculation attempts made under orchard conditions with the *Gloeosporium* fungus, ten positive cases of the disease resulted. The inoculations in this case were made with needle punctures, the only difference between this series of inoculations and those reported in the preceding table being that the inoculations in the orchard were made at normal air humidity while those reported in the table were made at an artificially maintained, high humidity. Control inoculations made with tap water and needle punctures again yielded entirely negative results. The *Gloeosporium* fungus was again reisolated from the inoculations resulting positively, and upon reinoculation upon Wase fruits again produced the disease. Inoculations have since been made repeatedly with positive results in reasonable percentages of cases. The postulates of Koch have thus been fulfilled, and the inoculation experiments lead to the statement that the disease of Wase Unshiu orange fruits is caused by this fungus of the genus *Gloeosporium*. The fungus was subsequently isolated from affected fruits obtained at Tsukumi. To the present time three different series of inoculations with this *Gloeosporium*, without punctures, have failed to reproduce the disease, indicating that the fungus is dependent upon wounds or bruises for entrance.

IDENTIFICATION OF THE FUNGUS

The fruiting bodies of the fungus occurring both naturally on diseased fruits and in culture are the typical *Gloeosporium* acervuli. The masses of spores resulting on the fruits are most often black en masse, but in fresh cultures are usually pink. The individual conidiophores are often branching as shown in figure 1 and are characteristically tapering at the tip. The spores when newly formed are elongate, slightly tapering to the ends, and the ends are usually rounded. In old cultures the spores may assume a number of eccentric shapes. When newly formed the spores are hyaline and few or no granular bodies are to be seen. Spores from old cultures, however, become something of an olive shade and are very granular; one or two vacuoles are frequently to be seen in old spores. The size of the spores is from 4.3 to 6.0 by 15.0 to 21.5 μ. Morphologically, therefore, the fungus agrees entirely with *Gloeosporium foliicolum* Nishida. The fungus has been grown in culture side by side with a known culture of *Gloeosporium foliicolum* obtained from herbarium material of that fungus forwarded by Doctor Nishida. Upon nutrient agar slants, potato plugs, poured plates, and orange-wood plugs, no cultural differences are discernible. The Wase rot fungus fruits several days more slowly than does the known culture of *Gloeosporium foliicolum,* but such a difference cannot be considered as an essential distinction.

A culture of Doctor Nishida's *Gloeosporium foliicolum* was then used as the inoculum for tests on Wase fruits. These inoculations yielded positive results in about 33 per cent of the tests, the lesions corresponding entirely with the Wase spot disease as it occurs in the field. These inoculation results, together with the morphological and cultural similarity, would indicate that the fungus causing the Wase rot is identical with *Gloeosporium foliicolum* Nishida.

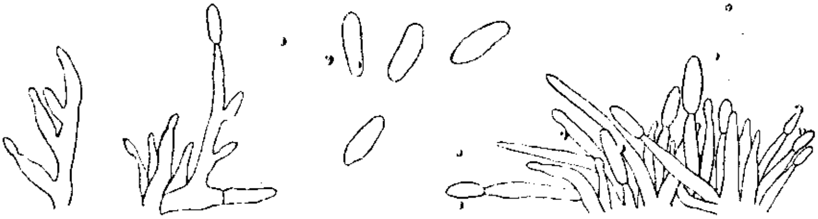

FIG. 1. *Gloeosporium foliicolum* Nishida, showing spores and conidiophores, × 500.

THE RELATIONSHIPS OF GLOEOSPORIUM FOLIICOLUM, G. LIMETTICOLUM, AND COLLETOTRICHUM GLOEOSPORIOIDES

Anthracnose and wither tip of limes, lemons, oranges, and pummelos ascribed to *Colletotrichum gloeosporioides* were reviewed and described from Florida by Rolfs.(8) He described this fungus as attacking small, newly formed lime fruits, newly formed lime twigs, mature lemons, newly formed twigs of lemon, and newly formed twigs of orange and grapefruit, but not the fruits of orange and grapefruit. Clausen (1) later has shown that wither tip of the lime and lemon was not due to *Colletotrichum gloeosporioides,* but to a species that is quite distinct in morphological and cultural characters and in physiological activities; he described this species as *Gloeosporium limetticolum.* Clausen did not have the opportunity to inoculate young lime fruits, although he states the opinion that the anthracnose of young lime fruits is probably due to *G. limetticolum.* Although the serious wither tip and anthracnose of the lime and lemon are due to *G. limetticolum, Colletotrichum gloeosporioides* is regarded by Fawcett(5) as the cause of rots of mature fruits of citrus varieties. Darnell-Smith and Mackinnon(3) in New South Wales have also described a disease, brown spot of Emperor mandarin orange fruits, which they ascribe to *C. gloeosporioides.* There are, therefore, two fungus species apparently pathogenic upon *Citrus* species, neither of which has been considered by Nishida in describing his new *Gloeosporium* species.

Nishida's(7) description of this species is in Japanese, and since it is probably inaccessible to most American and European pathologists, a translation is presented here:[1]

> There are differences between this disease and *Gloeosporium citricolum* Massee in the respect that the former has septa in its conidiophores and its conidiophore branches. So these two fungi are clearly different. Since to my knowledge no fungus has been previously described similar to this, parasitic on citrus trees, I recognize it as a new species and name it *Gloeosporium foliicolum* sp. nov.
>
> Its characters are as follows: The groups of spores grow often below the cuticle on the upper sides of the leaves. Later the cuticle of the leaf splits and the groups of spores upheave. The spores scatter or sometimes ooze. The color of the spore group is light reddish brown and its diameter is about 120 micro-millimeters. It also grows on the surface of the dead, newly grown twig and fruits. The conidiophores grow densely in bundles; the shape of each conidiophore is cylindrical and its tip is slightly pointed; it is frequently branched. It has two or three septa and is colorless; its length is 36–48 μ and its width is 4–5 μ. The spore grows on the tip of the conidiophore and has no curve; the tip of the spore is round and is slightly sharp (narrowing or pointed); there are few granular things in its body and it is colorless; it is twenty to fourteen μ in length and 4–6 μ in width. It germinates from one end.
>
> This fungus parasitizes all citrus trees but gives specially much damage on navel orange, unshiu orange, and natsu daidai.

In conversation with Doctor Nishida it developed that in describing this fungus as the cause of a leaf-fall disease of *Citrus,* the organism had not been isolated in culture nor had subsequent inoculations been made. It has seemed desirable, therefore, to compare this fungus with the closely related pathogenic species on *Citrus, Colletotrichum gloeosporioides* and *Gloeosporium limetticolum.*

The following cross-inoculation data and comparisons are therefore submitted, not as entire proof of the validity of

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[1] The translation of this passage from Nishida's book on citrus diseases is through the kindness of Mr. T. Takahashi, formerly plant inspector, Nagasaki Plant Quarantine Station.

G. foliicolum but as work that may be of assistance to a later investigator.

The Japanese fungus on mandarin and Unshiu oranges.—The Japanese disease in the field has been confined entirely to fruits of the Wase Unshiu variety and no cases were observed upon other species such as the sweet orange, *Citrus sinensis;* the lemon, *Citrus limonia;* the pummelo, *Citrus maxima;* or the sour orange, *Citrus aurantium.* Trees of the five other recognized varieties of the Unshiu orange commercially grown in Japan in many cases were observed in the same orchards, side by side with trees of the Wase variety; nevertheless, none of the Wase rot was ever observed upon such other varieties. The Wase Unshiu variety is an early-bearing variety; in fact, a translation of the Japanese word Wase is early. Fruits of the Wase variety mature during the summer heat of early September, while the other varieties mature in late October, November, or even December when the temperature is 30 to 40° F. lower.

Inoculations made in the field upon immature fruits of the Zairai, Ikeda, and Ikiriki varieties resulted entirely negatively in early October, while identical inoculations upon the Wase variety resulted positively. Later inoculations were made upon mature Zairai fruits removed from the trees and held in an incubator at 26 to 28° C. These resulted positively in two out of ten cases in the first test and in one out of ten cases in the second series. Inoculations upon fruits of the Ikiriki Unshiu orange under the same conditions resulted in one positive case from a total of ten fruits, and in the second series in seven cases from a total of ten fruits. It seems reasonable to conclude from this, therefore, that the lower temperatures at the time of maturing of the Ikiriki and Zairai Unshiu varieties limit the disease on these varieties, and that the occurrence of the disease in the field on the Wase variety alone is not a host restriction but a temperature limitation.

A series of inoculations upon Wase Unshiu fruits as compared with inoculations upon Batangas (Philippine) mandarin oranges, resulted in 65 per cent positive cases from twenty Wase Unshiu orange fruits and 55 per cent positive cases from twenty Batangas mandarin orange fruits. The Batangas mandarin orange, a form of *C. nobilis* var. *deliciosa,* was therefore readily susceptible to this disease; apparently then the Japanese fungus is capable of infecting mature fruits of either the Unshiu or the mandarin oranges if temperature conditions are favorable.

Inoculations upon mature lemon, sweet orange, and pummelo fruits.—Inoculations in the incubator at 25 to 26° C. were then made upon mature fruits of American-grown lemons, *C. limonia*, and Japanese-grown Washington navel oranges, *C. sinensis*, and pummelos, *C. maxima*. Upon the pummelos (Hirado variety) two different series of ten fruits each were tried; all resulted negatively. The Washington navel fruits in two series of twelve fruits each all resulted negatively. The American lemons in a single series of twelve fruits also resulted entirely negatively. Control inoculations on twelve Ikiriki Unshiu fruits resulted in 58 per cent positive cases. These data can best be seen in tabular form as follows:

TABLE 2.—*Showing results of inoculations with infusion of spores of Gloeosporium foliicolum on fruits in incubator at 25 to 26° C., each fruit inoculated with one needle puncture.*

Variety.	Fruits inoculated.	Date of inoculation.	Positive results.	Date of results.
		1919	*P. ct.*	1919
Zairai Unshiu orange	10	October 30	20	November 20.
Do	10	November 5	10	December 7.
Ikiriki Unshiu orange	10	November 5	10	December 7.
Do	10	October 14	70	December 6.
Hirado Buntan (pummelo)	10	November 5	0	December 7.
Do	10	October 30	0	November 20.
Washington navel orange	20	October 14	0	November 10.
Do	12	October 23	0	November 20.
American lemons	12	October 23	0	November 20.
Ikiriki Unshiu orange	12	October 23	58	November 20.

From these results it would seem that the fungus is restricted to the fruits of *Citrus nobilis*, and has no pathogenicity on fruits of other species.

The results from the foregoing series of inoculations in the incubator were repeated under orchard conditions, using both fruits and twigs. Since Clausen's opinion is that anthracnose of young lime fruits is due to *Gloeosporium limetticolum*, emphasis was placed upon the inoculation of such young fruits since the results would show definitely the similarity or differences between the Japanese fungus and *G. limetticolum*. The results are shown in Table 3.

These inoculations show clearly the pathogenicity of the Japanese *Gloeosporium* on mandarin oranges and the entire absence of pathogenicity on young lime fruits or mature limes, lemons, or sweet oranges. Further inoculations were made on fifteen young, actively growing Tahiti lime twigs; twenty young, actively growing leaves of Unshiu orange trees; thirty old senile leaves of the same species; and twelve twigs of a mandarin orange tree. The results of the last inoculations were entirely negative in each case, while controls on Batangas mandarin orange fruits were positive.

TABLE 3.—*Showing results of inoculations with control punctures and punctures with infusion of spores of Gloeosporium foliicolum on fruits under orchard conditions.*

Variety.	Condition.	Fruits inoculated.	Inoculum.	Incubation period.	Positive results.
				Days.	*Per cent.*
Batangas mandarin oranges	Mature	20	Water	15	0
West Indian limes	do	20	do	15	0
American lemons	do	20	*G. foliicolum.*	15	[a]0
Sweet oranges	do	20	do	15	0
Batangas mandarin oranges	do	20	do	13	55
West Indian limes	do	40	do	15	0
American lemons	do	20	do	15	[a]0
Sweet oranges	do	20	do	15	[a]0
Tahiti limes	Newly formed	8	do	15	0

[a] Slight gumming at few of the inoculations but could scarcely be called positive.

The inoculations were repeated with similar results; all the inoculations on twigs remained negative, while on mandarin orange fruits positive results were obtained. Apparently, if, as described by Nishida, this fungus causes a wither tip disease of young, actively growing twigs, a peculiar set of environmental conditions is necessary or a weakened host plant is essential. In the cases of *Colletotrichum gloeosporioides* Penzig, such is the case according to R. E. Smith and E. H. Smith, (9) E. O. Essig, (4) and R. E. Clausen. (1)

The results would seem to warrant the retention for the present at least of Nishida's species, *Gloeosporium foliicolum,* since it is particularly pathogenic to mature fruits of the Unshiu and mandarin oranges, *Citrus nobilis;* while of the closely related species it is distinguished from *Colletotrichum gloeosporioides* by its absence of pathogenicity on mature fruits of lemon and sweet orange, *C. limonia* and *C. sinensis,* and from *Gloeosporium limetticolum* by being nonpathogenic to young fruit and twig tissues of the lime, *C. aurantifolia.*

The pressure of other work prevents a more complete study of these three fungi, morphologically and in culture as well as physiologically.

Since writing the foregoing account I have been able to obtain an English translation of the Japanese article "On the pathogenic nature of Nishida's anthracnose fungus of citrus," by Dr. Takeo Hemmi.(6)

Hemmi, working with potted plants, carried on five experiments, using an inoculum of *Gloeosporium* spores in sterile water obtained from cultures from herbarium material of Nishida's fallen-leaf disease. In the first experiment, this inoculum placed on the leaves of Unshiu orange, navel orange, bitter orange, and pummelo resulted negatively in all cases. There is no mention of bell jars or moisture chambers in this experiment and apparently the inoculations were carried on in the open air.

In the second experiment, using the same inoculum, leaves of a potted plant of the Unshiu orange were inoculated; leaves of a potted plant of the sour orange (*Citrus aurantium* presumably) were similarly inoculated and both plants placed under bell jars and extremely moist conditions obtained with damp filter paper. Two days after the inoculation the bell jars were removed. The sour orange tree remained negative during twelve days after inoculation, but three leaves on the Unshiu orange tree turned brown, the leaves dropped and *Gloeosporium* acervuli appeared in a few days.

The third experiment consisted of the inoculation of the same material onto leaves of potted plants of the Unshiu orange and navel orange; bell jars and moist filter paper were maintained around the plants for three days after the inoculation and the plants were then restored to the normal air of the room. After twelve and thirteen days, spreading brown spots appeared on the leaves of the Unshiu orange and the leaves soon fell to the ground. *Gloeosporium* acervuli formed on the fallen leaves. Uninoculated leaves on the same plant remained healthy and did not fall from the tree. In none of the inoculations were artificial punctures or other injuries given to the leaves. No changes whatsoever occurred on the inoculated leaves of the navel orange.

In the fourth experiment, with similar methods, inoculations were made on leaves of a sour orange tree and on leaves of a pummelo. All leaves remained negative with the exception of one leaf of the sour orange which formed the typical spreading brown spot and fell to the ground. Doctor Hemmi was of the opinion that this positive result occurred at a naturally occurring wound.

In the fifth experiment, with similar methods, leaves of Unshiu orange, sour orange, and pummelo were inoculated. The young leaves of the Unshiu orange showed positive results and fell to the ground; on placing in a moist chamber they developed *Gloeosporium* acervuli. The leaves of the sour orange and pummelo remained negative as did also uninoculated leaves of the Unshiu orange.

These experiments, although apparently on a small scale, would indicate that under unusual weather conditions *Gloeosporium foliicolum* can attack normal leaves of the Unshiu orange; but that the fungus is but slightly pathogenic, if at all, to other *Citrus* species. The conclusions are also in agreement with those of the present paper pointing to the host restrictions of this fungus to *Citrus nobilis* and the validity of Nishida's *Gloeosporium foliicolum.*

Hemmi in his conclusions is apparently of much the same opinion in regard to the pathogenicity of this fungus on foliage as are investigators in California in regard to the pathogenicity of *Colletotrichum gloeosporioides;* that is, that unusual climatic conditions must be favorable to the fungus for it to become pathogenic to the foliage. In fruit inoculations we have found that such unusual conditions do favor pathogenicity but are not essential.

DISCUSSION

The Japanese disease on Unshiu oranges is quite possibly identical with the disease of emperor mandarin oranges described from Australia. Although the lesions on Unshiu oranges are slightly larger than are the lesions shown in the photographs by Darnell-Smith and Mackinnon (3) on mandarin oranges in Australia, such a slight difference could easily be explained by differences in host reactions. The cross inoculation experiments reported here cannot be considered as more than preliminary, yet they warrant the consideration of Nishida's *Gloeosporium foliicolum* as distinct from *Gloeosporium limetticolum* Clausen and *Colletotrichum gloeosporioides* Penzig. For the purposes of plant quarantine work also it seems justifiable to regard the disease of mandarin and Unshiu oranges as distinct from other kinds of anthracnose and wither tip on *Citrus* hosts. Anthracnose of mandarin oranges does not yet exist in the Philippines, nor has it been reported from America. It is especially important to the Philippines, where mandarin oranges are the principal commercial citrus crop, that this disease be excluded.

SUMMARY

1. A disease exists in Japan upon the Wase Unshiu orange variety, which has been observed to cause a loss of 20 per cent of the crop and is capable of causing even greater losses. Although the disease is confined to this one variety in nature in Japan, inoculation experiments have shown that at higher temperatures the disease will affect other varieties of the Unshiu oranges and also mandarin oranges.

2. The disease is described and isolation and inoculation experiments are reviewed showing the disease to be caused by a fungus identical with *Gloeosporium foliicolum* Nishida.

3. Inoculation experiments with this fungus on different *Citrus* species are also reviewed, indicating in a preliminary way that *Gloeosporium foliicolum* is a valid species and distinct physiologically from *Gloeosporium limetticolum* and *Colletotrichum gloeosporioides.* It is pointed out that, in the light of inoculation experiments, countries where this disease is not yet reported are justified in preventing the introduction of this fungus.

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ILLUSTRATIONS

PLATE 1. Anthracnose of Wase Unshiu oranges in Japan caused by the fungus *Gloeosporium foliicolum* Nishida.

TEXT FIGURE

FIG. 1. *Gloeosporium foliicolum* Nishida, showing spores and conidiophores, × 500.

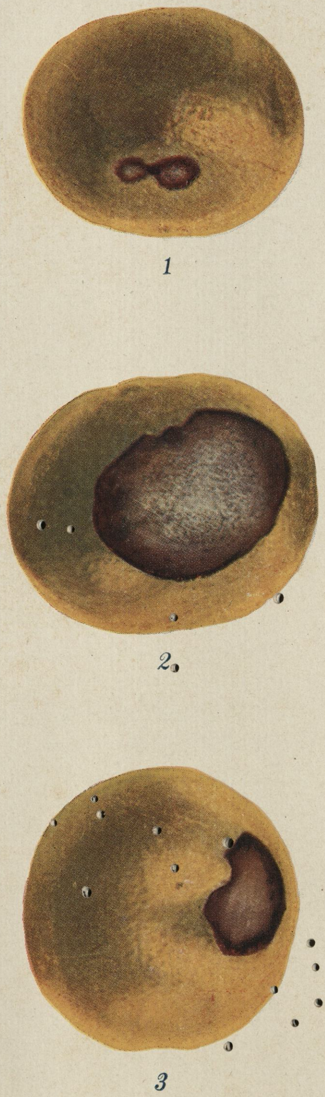

PLATE 1. ANTHRACNOSE OF WASE UNSHIU ORANGES IN JAPAN CAUSED BY THE FUNGUS GLOEOSPORIUM FOLIICOLUM NISHIDA.

THE SOLID BITUMENS OF LEYTE

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TWO PLATES AND TWO TEXT FIGURES

Natural solid bitumens occur in Leyte Province in two forms: pure bitumens and bitumen-impregnated rocks. The outcrops of pure bitumen occur in thin veins, while bitumen-impregnated rocks are found disposed in strata and in faults. Maps drawn by Pratt, who does not distinguish between the two varieties of bitumens, show the location of bitumen throughout the island.[1] One of these maps is reproduced here as text figure 1.

The pure bitumens of Leyte possess but little interest from the point of view of industrial development. Their applications might be numerous if large quantities of the material existed, but it has been found in very limited amounts. However, the rock presents a certain scientific interest, as it differs from all known mineralogical species of pure bitumen, and the study of its composition is also interesting in view of its relationship to the second variety of bitumens. The latter presents considerable economic importance as it occurs in large quantities and has been found practicable for road building.

In view of this, I will give only a cursory description of the pure bitumen and will consider the bituminous rocks in somewhat greater detail.

PURE BITUMEN

The samples of this material which I studied have been taken from outcrops that were disposed horizontally at the foot of a hill, within a layer of shale, covered by a layer of clay, about 2 to 3 kilometers southeast of Campocpoc, west of Bagubao River, in the northwestern part of the island. They had the appearance of dark brown stones of considerable hardness and brittleness and conchoidal fracture, yet they were not sufficiently brittle to be pulverizable. Their surface, lustrous when fresh, presented greasy spots when aged, betraying the lack of perfect homogeneity. Rubbed against unglazed porcelain the rock leaves a brownish yellow streak.

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[1] Philip. Journ. Sci. § A 10 (1915) 241.

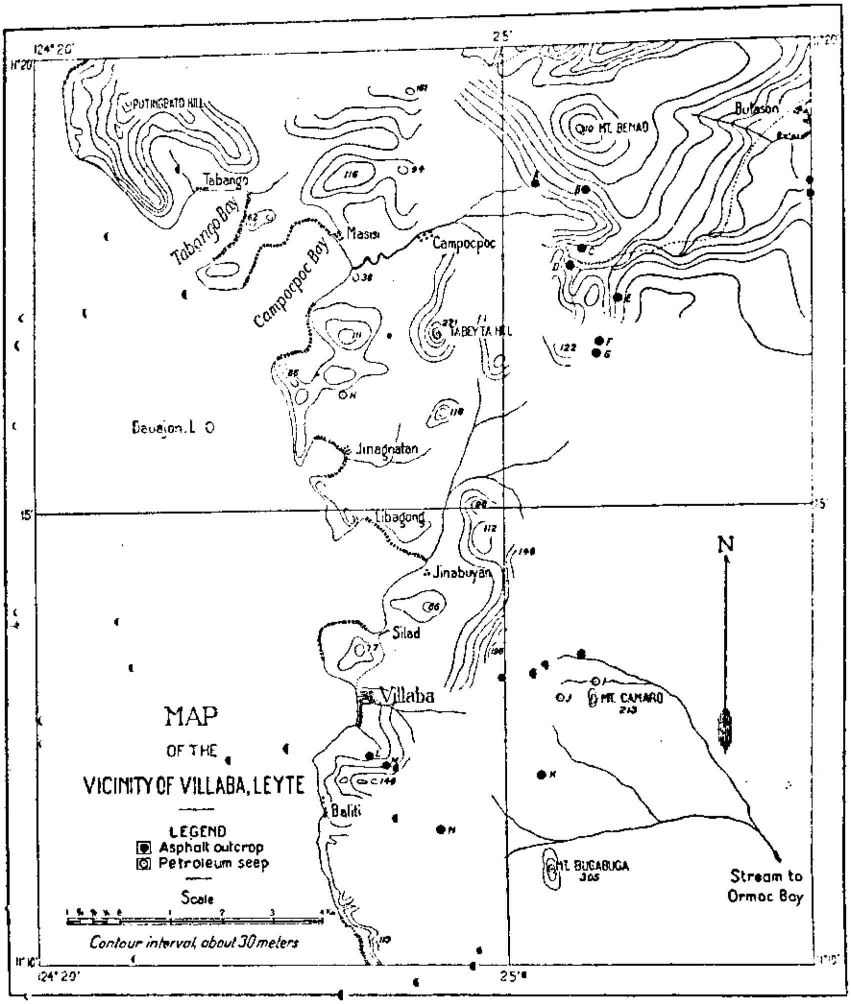

FIG. 1. The vicinity of Villaba, Leyte, showing the situations of outcrops of natural bitumens and seepages of petroleum.

Constants of pure bitumen of Leyte.

Physical constants:	
Melting point (capillary) (° C.)	61.5
Specific gravity at 25° C. (77° F.)	0.978
Ductility	0
Penetration (degrees)	2
Chemical constants:	Per cent.
Ethyl acetate soluble (paraffins)	81.5 –90.5
Ethyl acetate insoluble (asphalt)	7.9 –14.5
Mineral matter	0.5 – 2.8
Volatile matter at 265° C.	1.15
Fixed carbon	8.76– 9.99

On distilling, the rock commences to emit gases at temperatures above 300° C.; these gases are only partly condensable and are due to the breaking up and decomposition of paraffin hydrocarbons of high molecular weight into hydrocarbons of lower series. Distilled hydrocarbons represent about 70 per cent of the total weight of the rock; noncondensable gases, about 3 per cent; and the residue consists of the remaining 27 per cent which has become carbonized. The distillate, which is a mixture of solid and liquid hydrocarbons, constitutes a vaselinelike or butterlike grease, leaving a greasy spot on paper. It acts as a perfect mineral lubricant. Alcohol dissolves only the liquid oil, leaving the solid hydrocarbons behind as a yellow wax.

The ethyl acetate insoluble (asphalt) portion of the bitumens is always hard; it dissolves in benzene and, on evaporation of the solvents, deposits at the bottom of the vessel a brilliant black lacquer which scarcely adheres to the vessel. On heating, it does not melt, but softens at high temperatures.

The ethyl acetate soluble (paraffins) extracted from the bitumens presents a hard waxy substance, dark brown when seen in large masses, but reddish yellow when observed in thin layers. Solutions in all solvents present a very marked fluorescence. The ethyl acetate soluble being a mineral wax, it is very important to ascertain whether it consists of ceresin or of paraffin hydrocarbons. Its melting point, 60 to 61° C., is at the limit of that of paraffins and ceresin hydrocarbons, but its extraordinary capacity for crystallization and some of its physical properties, particularly its brittleness, indicate that it consists mostly of paraffin.

Leyte pure bitumens are essentially mineral waxes and must be classified as such, in spite of the admixture of 10 per cent (on the average) of ethyl acetate insoluble asphaltenic elements. The only varieties of natural mineral waxes hitherto known were those slightly metamorphosed residues of paraffinaceous petroleum which contain practically no asphaltenic ingredients, such as ozocerite, montan wax, hatchettite, and scheererite. It would be quite impossible to classify this rock as montan wax, hatchettite, or scheererite; the following circumstances make it difficult to classify it as ozocerite either. Ozocerite is subjected industrially to a process of refining which consists in heating it with about 20 per cent by weight of concentrated sulphuric acid to 280 to 300° C. until the evolution of sulphur dioxide fumes ceases. Concentrated sulphuric acid attacks and destroys unsaturated hydrocarbons and resinous matter, while volatile hydrocarbons are eliminated in the process of heating; there remains ceresin, which is a mixture of saturated hydrocarbons of high molecular weight. Ceresin is a species of mineral paraffin wax, but it is distinguished from the substance ordinarily designated paraffin by having a higher molecular weight, a higher melting point, a higher specific gravity, and a higher index of refraction, and by being flexible, noncrystallizable, and less soluble in organic solvents. Ozocerite is mined only for the purpose of obtaining ceresin. This being the case, a mineral which is not composed of ceresin should not be called ozocerite. No ceresin can be obtained from Leyte bitumens by a process of refining similar to that used for refining ozocerite. The paraffin extracted from Leyte bitumens is a hard and nonplastic substance with a penetration at 77° F. of 4° while ceresin is a plastic mass whose penetration at the same temperature is 20 to 30°. Finally, ozocerite is, as its name indicates, an odorous wax; the Leyte rocks have no odor at ordinary temperatures.

A natural mineral wax has been mined for the last thirty years in Colorado which has received no name as a mineralogical species and is commonly referred to as "ozokerite-like wax" or "so-called ozokerite of Colorado." Judging by the descriptions[2] the Colorado rock has certain points of resemblance to the Leyte pure bitumen. Like the latter, it does not yield ceresin, this being the reason why it is not classified as an ozocerite, and it produces paraffin wax on being distilled at temperatures above 360° C. From the descriptive literature, however, it is evident that it represents a species different from our Leyte bitumen since, unlike the latter, it does not contain a considerable quantity of asphaltenic ingredient insoluble in light petroleum naphtha and in boiling ethyl acetate. The Colorado bitumen, moreover, is pulverizable, smells of catechu, melts at 76° C., and yields 90 per cent of paraffin and oil on distillation.

Thus we see that our Leyte rocks cannot be classified as any of the known varieties of bitumen and should be given a special name. Leyteite, as it can be called, belongs to the group of mineral waxes and is related to ozocerite more than to any other mineral.

BITUMEN-IMPREGNATED ROCK

The samples of this material that I analyzed were obtained from the Lucio mine, the property of the Leyte Asphalt and Mineral Oil Company. According to Dr. Roy E. Dickerson,[3] who kindly provided me with these samples,

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[2] Lach, Chem. Ztg. 13 (1889) 831; Journ. Soc. Chem. Ind. 8 (1889) 696.

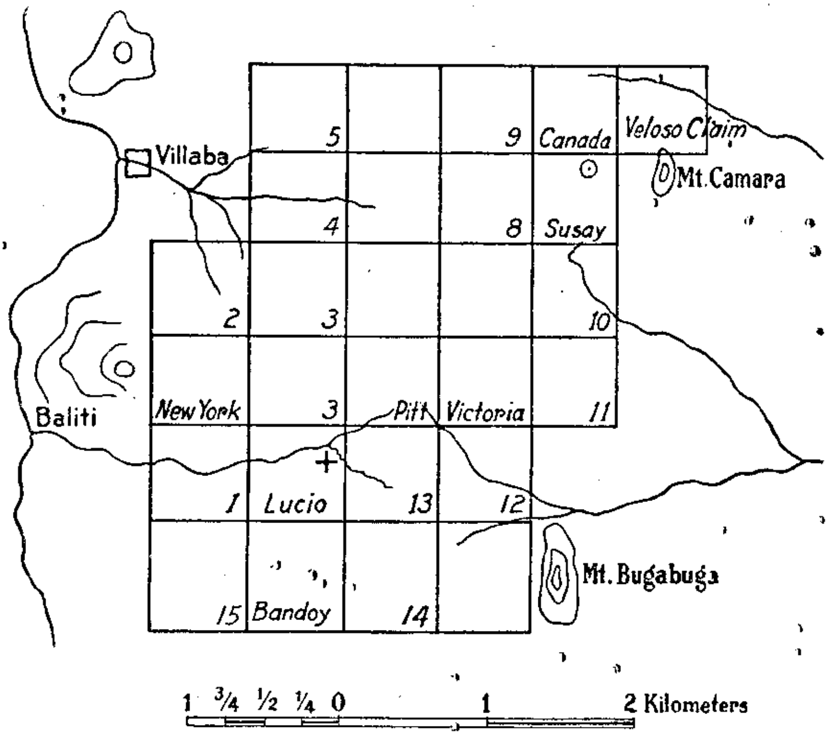

FIG. 2. Claim map, vicinity of Villaba.

This deposit is situated about 3 kilometers east of the small barrio of Baliti and about 5 kilometers south 30° E. from the municipality of Villaba on the west coast of the northwest peninsula of Leyte. The mine is on the south side of Baliti Creek near its head and a very excellent open face is exposed on the creek side for a distance of about 300 feet in an east-west direction. The bituminous strata have a dip of about 10 to 15 degrees in an easterly direction and rest upon typical clay shales of the Vigo group. * * * The bituminous strata are about 50 to 75 feet in thickness and are possibly traceable in a southern direction for 600 feet. These strata are essentially andesitic tuff. * * *.

The bituminous tuff at the Lucio mine is essentially a fault block. * * * Besides this large block * * * another small block is recorded by Mr. William Anderson, * * * as occurring a half mile to the north. The quantity of material in this large block has been variously estimated from a half million tons to as high as twenty million tons. The material is mined by open-cut methods and taken to the beach on a small narrow-gauge railway. These two occurrences of rock asphalt near Baliti are the only ones known in this general region. Seepages of petroleum and leyteite occur a few miles north and northeast of Baliti. Pratt describes these other localities in detail in * * * Phil. Jour. Sci. 10, Sec. A. 1915.

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[3] In a personal communication dated September 20, 1922.

The rock is dark brown, almost black. Its granular structure is easily perceivable with the naked eye. The grains are so thoroughly cemented that the rock is very hard to break in pieces, even with the aid of a knife or a hammer. Nevertheless, it can be crushed by means of the disintegrator and gives a slightly sticky powder. The impregnation is not quite homogeneous.

The chemical and physical examination of the rock must be preceded by an inquiry as to the possible industrial utilization of the material; the relative importance of the various tests is, of course, dependent on the uses to which the material is destined.

Two possibilities of commercial utilization of the bituminous rock must be considered: One is the separation of the bituminous substance from the admixture of worthless sand which it impregnates; the other is the utilization of the raw material, either in the form in which it occurs or amended by the introduction of more bitumen or sand.

The extraction of bitumen is impracticable from the point of view of treatment on a large scale. It would, of course, be possible to extract the bituminous substance, particularly its paraffin wax, by means of organic solvents such as, for instance, light petroleum ether; the expense, however, would be quite prohibitive, as a very considerable portion of the solvent would escape recovery. Boiling water is sometimes used in Europe as a means of separating the bitumen in bituminous sand; this treatment is founded on the principle that bitumens melt below the temperature of boiling water and, as they are lighter than water, they will float on the top of the liquid, while the sand, being relatively heavy, will settle at the bottom. This treatment does not succeed with the Leyte impregnated rock, as it is mainly composed of carbonated lime, and bitumen is known to adhere to calcium carbonate with an incomparably greater tenacity than it does to silica when boiled with water. Dry distillation is impracticable on account of the low percentage of bitumen in the rock, which would necessitate the use of stills of very large size for the recovery of relatively small amounts of distillate.

One method of separating the bitumen from the mineral matter deserves special mention. It is founded on the circumstance that the impregnated mineral ingredient in our case consists mainly of salts which give, with hydrochloric acid, soluble chlorides. A glance at the composition of the rock, freed from bitumen, will explain the reaction, see page 626. If at some time in the future muriatic acid is produced in the Philippine Islands, particularly if it is obtained as a by-product, its use in the treatment of Leyte bituminous rocks will become very advantageous for the recovery of bitumen for road building and other purposes. Treatment with hydrochloric acid would reduce the freight and the cost of transportation of the bitumen; it would also adapt the bituminous substance, free from most of its inorganic impurities, to various uses for which the crude rock is not fitted.

Since no method of extracting the bitumen, wholly or partially, can be utilized industrially, Leyte bituminous rock can only be used for road surfacing. It therefore requires tests as to its adaptability for this particular purpose only.

As a matter of fact, the rock we are considering is already successfully used for road building. Mr. G. M. Veloso, treasurer of the Leyte Asphalt and Mineral Oil Company, Cebu, states that the above-named company—

> shipped a total of about 2500 tons of asphalt rock from their quarry which is located about 3 kilometers east of Baliti. Of this amount 1000 tons were shipped to Japan and the 1500 tons remaining were used for street paving in Manila, Cebu and Zamboanga. At present [September 19, 1922] the Asphalt Company has about 3,800 tons of asphaltic rock on the beach at Baliti ready for shipment to Japan.

In Japan, the material is used for road building.

Bituminous compounds used for paving consist of two components: The mineral aggregate which is the resisting ingredient and the bitumen which acts as a cement for the mineral aggregate. The resistance of the pavement to the wear of traffic is entirely dependent upon the mineral aggregate, but the coherency of the latter requires the presence of bitumen in proper amounts and of proper quality. This being the case, it is clear that, in order to determine the adaptability of our rock for use as a paving material and to be able eventually to remedy its defects and improve upon the material, it is important to examine qualitatively and quantitatively its two constituents.

For this purpose, samples of the rock were first separated into bitumen, which was completely extracted by the use of solvents such as benzene and carbon disulphide, and the mineral matter. The penetration of the rock not being homogeneous, the results were variable. One sample (A) of 25.4230 grams gave the following results:

Constituent.	Quantity.	
	g.	*Per cent.*
Moisture and volatile matter	0.5756	2.26
Bitumen	2.0640	8.1
Mineral matter	22.7834	89.6
Total	25.4230	99.96

The volatile matter here consisted of liquid hydrocarbons which are volatile at temperatures around 100°, particularly in the presence of water. Without volatilization the bitumen content would be in the neighborhood of 10 per cent.

A large sample of rock (B) weighing 273.5 grams was attacked with hot dilute muriatic acid and extracted with benzene. After volatilization of the solvent by prolonged heating at 100° C., the extracted bitumen weighed 30.12 grams, or 11 per cent of the crude rock.

The bitumens of the two samples were treated separately with boiling ethyl acetate for the purpose of separating the paraffinaceous ingredient, which is soluble, from the insoluble tarry asphalt. The results were as follows:

Soluble and insoluble ethyl acetate in Samples A and B.

Sample—	Ethyl acetate.		
	Soluble.	Insoluble.	
	g.	*g.*	*Per cent.*
A	1.4710	0.5930	28.73
B	25.4131	6.7069	22.28

The bitumen of the impregnated rock is thus found to be considerably richer in asphaltic constituent than is Leyte pure bitumen. Pratt's[4] supposition that Leyte bitumens are derived from evaporation of paraffinaceous petroleum is evidently incorrect, since paraffin-base petroleums could never have left residues so rich in ethyl acetate insoluble as are Leyte bituminous rocks.

The physical characteristics of the rock bitumen are totally different from those of the pure bitumen. The rock bitumen is extremely sticky and has the appearance of a heavy maltha of viscous and semifluid consistency. Neither the penetration test nor the ductility test can be made on such a substance. The fixed

[4] Pratt, W. E., Philip. Journ. Sci. § A 10 (1915) 241.

carbon is 11.04 per cent. The stickiness and the viscosity of the rock bitumen is entirely due to the ethyl acetate soluble (paraffins) which, when extracted, was found to possess these characteristics, while the ethyl acetate insoluble (asphalt) was in all respects similar to the ethyl acetate insoluble of Leyte pure bitumen.

This difference between the paraffinaceous constituents of Leyte pure bitumen and of Leyte bituminous rock could be expected since mineral aggregate mixed with bitumen prevents to a certain extent any evaporation from the bitumen. Originally, as may be supposed, both varieties of bitumen were very similar, except perhaps in the content of the asphaltic ingredient, which may or may not have been increased in the rock bitumen at the expense of the paraffinaceous portion by the catalytic action of the mineral aggregate. At present, the rock bitumen differs from the pure bitumen by the presence of relatively volatile paraffin hydrocarbons, some of which are liquid and others semifluid. This difference apparently illustrates the relative stability to the action of atmospheric agents conferred upon bitumens, by the admixture of mineral matter.

Natural asphaltic rocks seldom contain a sufficient quantity of bitumen to make them suitable for use as a paving material. In most cases bituminous fluxes have to be introduced to supplement this deficiency. Mastics containing as much as 15 and 20 per cent of bitumen are used in countries of temparate climate; but in tropical countries a much smaller percentage of bitumen is required. On the other hand, the amount of bitumen must also be regulated to the amount and character of the traffic. Pavements subjected to light traffic will require less rock than those destined to support heavy traffic. The properties of the flux to be mixed with our Leyte rock, if fluxing is found, advisable, must be carefully considered, as it is a well-known fact that the cementing properties of bitumen fluxes depend greatly on their composition which should be largely asphaltic. As our Leyte bitumen is largely paraffinaceous, the use of fluxes derived from asphalt-base petroleum, such as the Trinidad epure or heavy residues of distillation of asphaltic oils, is advisable.

The examination of the mineral aggregate which is penetrated with bitumen, has considerable importance in the road-building industry, in as much as the quality and the characteristics of the road surface are mainly dependent on the character of the sand which is cemented, and we have seen that this sand cannot be separated economically from our bituminous rock and another sand substituted for it. The study of mineral aggregates used in road building requires an examination of fineness of grain and the determination of chemical composition.

The mineral matter impregnated with bitumen in our case consisted of loose white grains which were held together because of the cementing bitumen and which crumbled to powder when the bitumen was extracted with solvents. The size of the grains was determined by Mr. A. E. W. King, of the Bureau of Science. The sand sieved as follows:

	Per cent.
Passing 200-mesh sieve	16.95
Passing 100-mesh sieve	12.13
Passing 80-mesh sieve	4.33
Passing 50-mesh sieve	18.02
Passing 40-mesh sieve	8.77
Passing 30-mesh sieve	17.92
Passing 20-mesh sieve	18.46
Passing 10-mesh sieve	2.73
Retained on the 10-mesh sieve	0.14
	99.29

The size of grains desirable in asphaltic pavements depends on the character of the traffic that the pavement is destined to bear. Very fine grains permit the obtaining of closely bound and smooth asphaltic surfaces, but the pavement thus obtained cannot withstand heavy traffic so well as can a pavement made of coarse sand. On the other hand, pavements made of coarse sand must contain a high percentage of bitumen, as otherwise they are likely to crack easily. In general, moderately sized grains, such as those of our samples, are preferable for all purposes. They have a sufficient content of coarse grains and an appropriate amount of fine particles to fill the voids between the coarse grains.

The chemical composition of our mineral aggregate, as determined by Mr. E. Gutierrez, of the Bureau of Science, was found to be as follows:

	Per cent.
Water	0.48
Silica (SiO_2)	7.48
Iron oxide (Fe_2O_3)	0.96
Aluminum oxide (Al_2O_3)	4.58
Calcium oxide	47.44
Magnesia (MgO)	1.82
Combined CO_2	37.20
Total	99.96

The above table shows that the mineral aggregate is essentially composed of calcium carbonate. The Leyte impregnated rock is thus found to be a bituminous limestone, and it remains to see what kind of pavement can be made of this material as compared with the pavements made from bituminous sandstone.

It is a well-known fact that in the United States roads are made of artificial mixtures of bitumen, silicious sand, and limestone, whereas in Europe natural bituminous limestones are used. The latter are principally obtained from deposits at Val-de-Travers, Switzerland; at Seyssel, France; at Ragusa, Sicily; and at Limmer and at Vorwohle in Germany. The bituminous content of these natural rocks averages 10 per cent, and the material is mostly used without the addition of fluxes or fillers by merely heating it and spreading the softened mass on an appropriate foundation. The roads thus obtained in Europe are of excellent quality.

According to A. Danby[5] experiments were carried out by Messrs. Durand-Clay and Debray to determine the resistance to crushing stress of artificially made bituminous limestone and bituminous sandstone. He states:

> Blocks of equal sizes were made of the two materials, and though that comprised of the bituminous limestone broke under an average pressure of 328 kgs. per square centimeter, that made with the bituminous sandstone only resisted up to a pressure of 217 kgs. per square centimeter.

These experiments show that bituminous limestone is considerably more resistant to traffic than bituminous sandstone and that we therefore have a very important point in favor of the Leyte rock.

When we come, however, to consider the action of atmospheric erosive agents on pavements, we find that calcarious pavements weather out a great deal more rapidly than do those made of bituminous sandstone. The reason is that rain water always carries a non-negligible proportion of carbonic acid; this reacts with calcium carbonate forming calcium bicarbonate which dissolves in water leaving behind the bituminous cement, and the latter, deprived of a portion of its mineral aggregate, softens and becomes inutilizable for traffic. This action of rain water is fortunately slow; but in a rainy country, like the Philippines, the damage resulting to the pavement is not inconsiderable. This condition could be remedied by the introduction of a certain proportion of silicious fillers.

---

[5] Natural Rock Asphalts and Bitumen. London (1913) 160.

In conclusion, we find in Leyte bituminous rock an excellent natural paving material from local sources which fortunately exists in quantities sufficient not only to satisfy local needs but also for exportation. Slight defects of this material could be remedied, as we have seen, by the introduction of proper fillers and fluxes, according to requirements.

SUMMARY

The natural solid bitumens occurring in Leyte Province have been classed as "pure bitumen" and bitumen-impregnated rock, and have been studied from a chemical and physical standpoint showing:

1. That Leyte pure bitumen differs from other mineralogical deposits of bitumens, such as ozocerite, montan wax, hatchettite, and scheererite, but is related to ozocerite. It is suggested that the pure bitumen of Leyte be termed leyteite.

2. That the chemical and physical properties of the bitumen found in the impregnated rock differ from those of the pure bitumen.

3. That the mineral aggregate of the bitumen-impregnated rock is principally limestone.

4. That the bitumen-impregnated rock would be suitable paving material, both in its natural state and after the introduction of fillers and fluxes.

ILLUSTRATIONS

PLATE 1

FIG. 1. A street in Cebu paved with Leyte asphalt.
2. A street in Cebu paved with Leyte asphalt.

PLATE 2

FIG. 1. Rock on the beach at Baliti.
2. Rock alongside the narrow-gauge railroad, Baliti.
3. Laborers at work, Lucio asphalt mine.

TEXT FIGURES

FIG. 1. Map, the vicinity of Villaba, Leyte, showing the situations of outcrops of natural bitumens and seepages of petroleum.
2. Claim map, vicinity of Villaba.

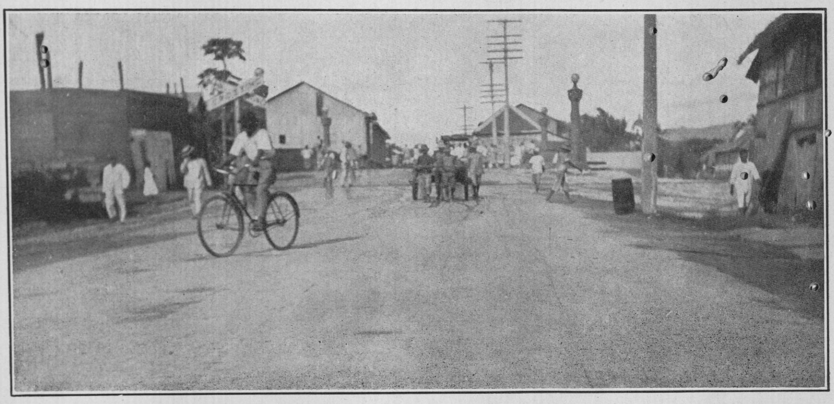


Fig. 1. A street in Cebu paved with Leyte asphalt.

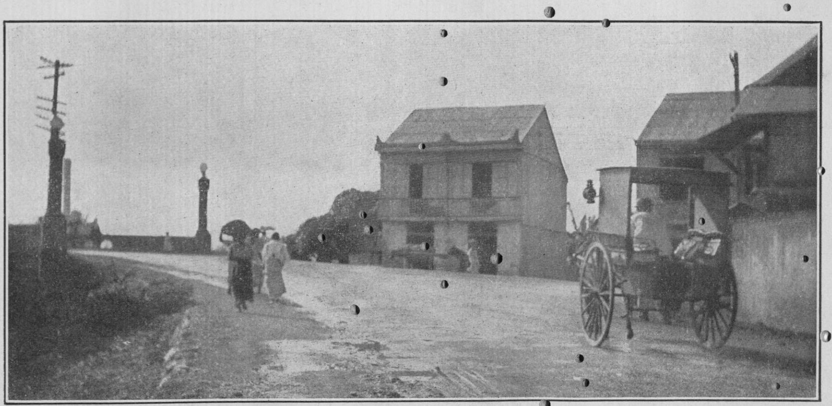


Fig. 2. A street in Cebu paved with Leyte asphalt.

PLATE 1.

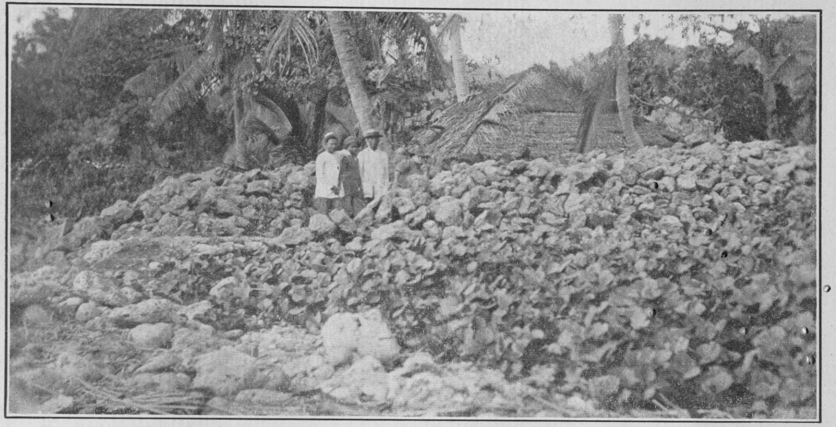


Fig. 1. Rock on the beach at Baliti.

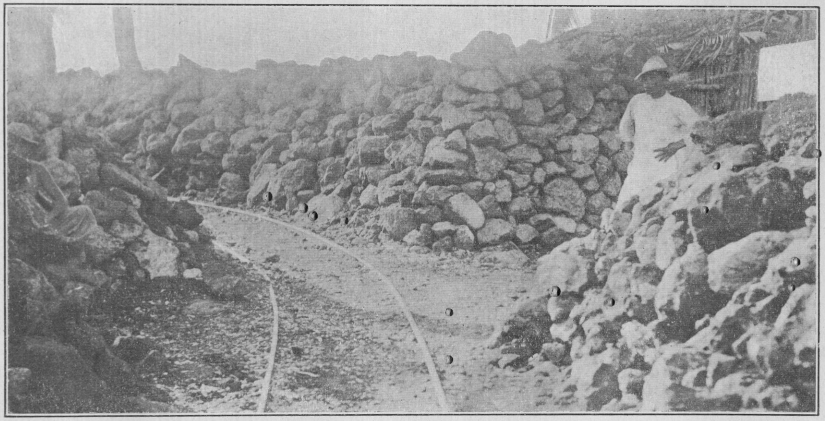


Fig. 2. Rock alongside the narrow-gauge railroad, Baliti.

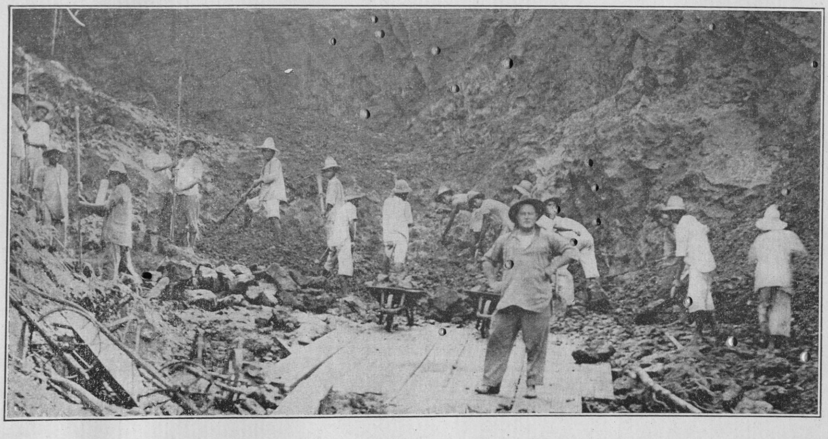


Fig. 3. Laborers working, Lucio asphalt mine.

PLATE 2.

HEXAMETHYLENETETRAMINE AS A REAGENT IN MICROSCOPIC QUALITATIVE CHEMICAL ANALYSIS[1]

By HOWARD IRVING COLE

Chemist, Bureau of Science, Manila

TWO PLATES

Hexamethylenetetramine (hereinafter referred to as hmt) forms crystalline compounds with many inorganic salts. Some of these compounds are quite insoluble. They are generally of the additive type and hence any attempt to utilize hmt as a reagent in qualitative analysis must take into consideration the negative as well as the positive ion of the compound to be analyzed. In microchemical qualitative analysis, it has been found possible to obtain characteristic crystalline precipitates with hmt for certain of the positive ions in any of their combinations by performing the test in hydrochloric acid solution. Vivario and Wagenaar[2] state that characteristic insoluble crystalline compounds are formed with salts of platinum, iridium, palladium, osmium, silver, mercury, antimony, bismuth, tin and, in the presence of potassium iodide, with magnesium. Denigès,[3] in 1919, suggested that hmt might be used for the detection of bismuth in any of its combinations. I have found that hmt may be used for microchemical detection of other elements besides those above mentioned.

The present paper gives the result of thousands of microchemical tests made with hmt on inorganic compounds to determine all the elements giving charactoristic crystalline compounds with this reagent; also the elements giving characteristic crystalline compounds with hmt and potassium iodide. The best method of applying the tests and their sensitivities have also been determined.

---

[1] Received for publication September 8, 1922.

[2] Pharm. Weekblad 54 (1917) 157. Unfortunately the original article was not available to me, but there is an excellent abstract in Chem. Abs. 11 (1917) 1385.

[3] Schweiz. Apoth. Ztg. 57 (1919) 497. Abstracted in Chem. Abs. 13 (1919) 2830.

EXPERIMENTAL

Salts of aluminium, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, cesium, cerium, chromium, cobalt, copper, gold, iridium, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, osmium, palladium, platinum, potassium, rubidium, selenium, silver, sodium, strontium, tellurium, thallium, thorium, tin, titanium, tungsten, uranium, vanadium, and zinc were tested with hmt in neutral and acid solution and with hmt plus potassium iodide in neutral and acid solution.

It was found that solutions of salts of antimony, bismuth, cadmium, gold, iridium, mercury, palladium, platinum, silver, and tin gave characteristic crystalline precipitates with hmt in solutions acidified with hydrochloric acid (silver is used in nitric acid solution). Salts of calcium, ferrous iron, magnesium, manganese, and titanium sometimes give crystalline compounds with hmt, but the crystals formed are not especially characteristic.

When a fragment of potassium iodide is added to a drop of a solution of hmt and a salt of antimony, bismuth, cadmium, palladium, platinum, or tin, characteristic crystalline compounds result. Calcium, iron, magnesium, and manganese[4] salts yield crystals which cannot be easily differentiated one from another. Free hydrochloric, sulphuric or nitric acid gives crystals with hmt and potassium iodide, but these crystals are easily distinguished from those formed with any of the above-mentioned metals (Plate 2, fig. 12).

Technic.—Of the various general methods of making microchemical tests,[5] the most satisfactory procedure proved to be that in which a fragment of the solid reagent is added to a drop of the solution of the substance to be tested. This drop should be from 2 to 4 millimeters in diameter. The preparation on the slide is then examined under a low-power microscope. Dilute solutions yield more nearly perfect crystals than concentrated ones. Scratching the drop with a small glass rod or platinum spatula is sometimes advantageous.

---

[4] Other metallic salts, such as those of arsenic, cobalt, lead, nickel, osmium, strontium, tellurium, and zinc yield crystalline compounds with hmt and with hmt and potassium iodide, but these compounds, being very soluble, will not interfere.

[5] Chamot, E. M., Elementary Chemical Microscopy, 1st ed. (1916) 251–259.

The sensitivity was determined by making the test on solutions of decreasing concentration until one was reached which gave no crystals. The concentration was figured in terms of the positive ion; that is, a 1 : 1,000 solution of silver nitrate contained 0.1574 g. $\left(\frac{AgNO_3}{Ag}\right)$ silver nitrate. The most dilute solution which gave crystals within about three minutes was taken as the limit of sensitivity.

TESTS WITH HEXAMETHYLENETETRAMINE

ANTIMONY

Sensitivity with hmt, 1 : 1,500.
Sensitivity with hmt + KI, 1 : 15,000.

When a fragment of hmt is added to a drop of a hydrochloric acid solution of an antimony salt, colorless octahedra and dodecahedra first appear. Toward the periphery of the drop square-ended prisms exhibiting parallel extinction then appear, gradually entirely replacing the crystals belonging to the isometric system. The latter seem to be unstable or soluble in excess of the reagent.

If no crystals appear, a fragment of potassium iodide is added to the test drop. Yellow octahedra are formed in the presence of antimony. Bismuth and tin also yield yellow octahedra, but the crystals are much smaller. The test should be performed in a solution acidified with hydrochloric acid. Nitric and sulphuric acids do not interfere. However, any one of these three acids will give colorless crystals in the presence of hmt and potassium iodide; the crystals are more soluble than the yellow octahedra formed with antimony, bismuth, or tin and, furthermore, are easily distinguished by form and color and by the fact that they exhibit parallel extinction under crossed nicols (Plate 1, fig. 1, and Plate 2, fig. 12).

BISMUTH

Sensitivity with hmt, 1 : 8,000.
Sensitivity with hmt + KI, 1 : 100,000.

Hexamethylenetetramine forms with bismuth compounds in hydrochloric acid solution large, colorless, highly refractive octahedra and dodecahedra belonging to the isometric system. Bismuth never gives crystals which polarize and may thus be distinguished from antimony (Plate 1, fig. 2).

When a fragment of potassium iodide is added to the test drop containing the bismuth salt and hmt there is immediately produced an amorphous yellow precipitate which gradually changes into tiny, yellow octahedra. This is an exceedingly delicate test for bismuth. See precautions noted under antimony.

Bismuth may be readily distinguished from tin by adding to a test drop a fragment of cesium chloride and then a fragment of potassium iodide. Bismuth yields orange-red hexagonal plates, while tin yields yellow octahedra.

Denigès[6] states that the compound of bismuth and hexamethylenetetramine has the formula

$$3(C_6H_{12}N_4.HCl).BiCl_3$$

According to Ley[7] the iodide compound may have one of the three forms

$$3(C_6H_{12}N_4.HI)BiI_3,\ 2(C_6H_{12}N_4.HI)BiI_3,\ \text{or}\ C_6H_{12}N_4.HI.BiI_3.$$

TIN

Sensitivity with hmt, 1 : 1,000.
Sensitivity with hmt + KI, 1 : 1,000.

In strong hydrochloric acid hmt forms with solutions of tin colorless octahedra (an amorphous precipitate is obtained in solutions which are neutral or only slightly acidified). The crystals are usually smaller than those formed with bismuth and the test is not so delicate.

The addition of potassium iodide gives rise to exceedingly tiny yellow octahedra gradually crystallizing from a yellow amorphous precipitate. See precautions under antimony.

CADMIUM

Sensitivity with hmt, 1 : 200.
Sensitivity with hmt + KI, 1 : 2,200.

Concentrated hydrochloric acid solutions of cadmium salts give with hmt thin, colorless plates belonging to the hexagonal system.

If potassium iodide is added to the test drop, highly refractive, square-ended, colorless prisms and hexagonal plates appear (Plate 2, fig. 9). These crystals belong to the hexagonal system and are very characteristic. See precautions under antimony.

[6] Loc. cit.

[7] Annalen 278 (1894) 57.

According to Ray and Sarker,[8] the cadmium iodide-hexamethylenetetramine compound may have the formula

$$2(CdI_2).2(HI)3(C_6H_{12}N_4) \text{ or } 2(CdI_2)2(C_6H_{12}N_4).$$

The following metals are grouped together because of the similarity of the crystals formed with hmt and with hmt + KI:

	Sensitivity with hmt.	Sensitivity with hmt + KI.
Calcium	1 : 200	1 : 1,000
Iron (Fe″)	1 : 1,000	1 : 1,000
Magnesium	1 : 100	1 : 1,000
Manganese (Mn″)	1 : 1,000	1 : 2,000

In hydrochloric acid solution they all yield triclinic, four- or six-sided plates with hmt. A similar type of crystal is given when potassium iodide is added (Plate 2, figs. 10 and 11). In all cases, the crystals form only around the melting fragment of hmt or potassium iodide.

COLD

Sensitivity with hmt, 1 : 900.

Gold chloride solutions yield with hmt very characteristic pale yellow needles or thin plates showing strong polarization with parallel extinction. These needles form either a kind of grid at 60° angles or rosettes of plates or needles. There is sometimes a tendency to form long, curved, hairlike needles (Plate 1, fig. 3). Since the crystals are soluble in excess of reagent, care must be taken to use only a very tiny fragment of hexamethylenetetramine in the test drop. The compound[9] formed has the formula $C_6H_{12}N_4 . AuCl_3$.

Mercury and silver interfere with the test for gold. The presence of palladium tends to make the gold come out as moss-like crystals. Platinum, palladium, and iridium are readily distinguished from gold by this test (Plate 1, fig. 5).

IRIDIUM

Sensitivity with hmt, 1 : 2,000.

Iridium salts yield with hmt highly characteristic tiny red-brown octahedra or crosses belonging to the isometric system. A large excess of reagent should be avoided. The crystals usually appear after a few minutes near the periphery of the drop and grow larger on standing.

---

[8] Trans. Journ. Chem. Soc. 119 (1921) 390.

[9] Moschatos und Tollens, Annalen 272 (1893) 277.

Palladium and gold do not interfere with the test for iridium. Platinum tends to make the red-brown octahedra a lighter shade. Silver and mercury interfere.

PLATINUM

Sensitivity with hmt, 1 : 5,000.

Platinum salts yield highly refractive pale yellow octahedra with hmt. As the platinum solution becomes more dilute the crystals formed when hmt is added become smaller. As the small crystals are almost colorless care must be taken not to confuse these with the colorless octahedra formed with hmt and bismuth or tin compounds. The platinum crystals, however, turn dark reddish brown upon the addition of a tiny fragment of potassium iodide.

The platinum-hexamethylenetetramine compound[10] has the formula $2(C_6H_{12}N_4 \,.\, HCl)PtCl_4+4H_2O$.

In the presence of iridium the platinum crystals are darkened somewhat, so that they have a color between the yellow of the platinum salt and the red-brown of the iridium salt.

In mixtures of platinum and palladium, the former usually comes out first, the latter on standing or by scratching. The two are readily distinguished under crossed nicols as the palladium crystals alone exhibit extinction. Large amounts of silver or mercury interfere with the test for platinum.

PALLADIUM

Sensitivity with hmt, 1 : 8,000.

Palladous salts yield with hmt characteristic, very thin, colorless plates strongly polarized under crossed nicols. The crystals tend to grow large if the drop is left undisturbed, but give small, thin crystals if the preparation is scratched (Plate 1, fig. 6). An excess of hmt is necessary. The crystals form around the melting fragment of hmt. When a tiny fragment of potassium iodide is added the crystals are colored a dark brown.

Mercury interferes with the test for palladium. See remarks under platinum.

MERCURY

Sensitivity with hmt, 1 : 1,000.

Mercuric salts form with hmt in neutral solution colorless, square-ended, slender prisms belonging to the monoclinic system (see Plate 2, fig. 8). The crystals often form rosettes of needles.

[10] Tollens, B., Ber. d. deut. Chem. Ges. 17 (1884) 655.

In concentrated solution they are usually feathery, appearing black by transmitted light and white by reflected light. In hydrochloric acid solution there are formed colorless plates and needles.

When free hydrochloric acid is absent the compound[11] has the formula $C_6H_{12}N_4.2HgCl_2+H_2O$. When hydrochloric acid is present the compound formed is $C_6H_{12}N_4.HCl.2HgCl_2+H_2O$.

SILVER

Sensitivity with hmt, 1 : 200.

Silver salts in nitric acid solution form with hmt colorless needles or plates belonging to the monoclinic system. The plates usually appear only when the preparation is scratched. They often show high polarization colors (Plate 2, fig. 7).

Palladium may interfere with the test for silver.

SUMMARY

Hexamethylenetetramine can be used as a reagent in microscopic qualitative chemical analysis for the identification of salts of antimony, bismuth, tin, cadmium, gold, iridium, platinum, palladium, mercury, and silver. It can also be used as a group test for calcium, magnesium, iron, and manganese. The crystal forms and the best method of applying the test have been described. The sensitivities of the various tests have been determined.

---

[11] Delépine, Compt rend. des Acad. sci. 120 (1895) 744. Schmiz, E., Ber. Pharm. Ges. 20 (1910) 201, gives the formula $C_6H_{12}N_4.2HgCl_2$.

ILLUSTRATIONS

[Magnification × 50.]

PLATE 1

FIG. 1. Crystals of antimony salt with hexamethylenetetramine in hydrochloric acid solution.

2. Crystals of bismuth salt with hexamethylenetetramine in hydrochloric acid solution.

3. Crystals of gold chloride with hexamethylenetetramine.

4. Crystals of platinum chloride with hexamethylenetetramine.

5. Crystals of the gold salt (fig. 3) and the platinum salt (fig. 4) formed with hexamethylenetetramine in a solution of gold and platinum.

6. Crystals of palladous chloride with hexamethylenetetramine.

PLATE 2

FIG. 7. Crystals of silver nitrate with hexamethylenetetramine.

8. Crystals of mercuric salts with hexamethylenetetramine in hydrochloric acid solution.

9. Crystals of cadmium salt with hexamethylenetetramine and potassium iodide in hydrochloric acid solution.

10. Crystals of magnesium salt with hexamethylenetetramine and potassium iodide in hydrochloric acid solution.

11. Crystals of manganous salt with hexamethylenetetramine in hydrochloric acid solution.

12. Crystals formed from a mixture of hydrochloric acid, potassium iodide, and hexamethylenetetramine.

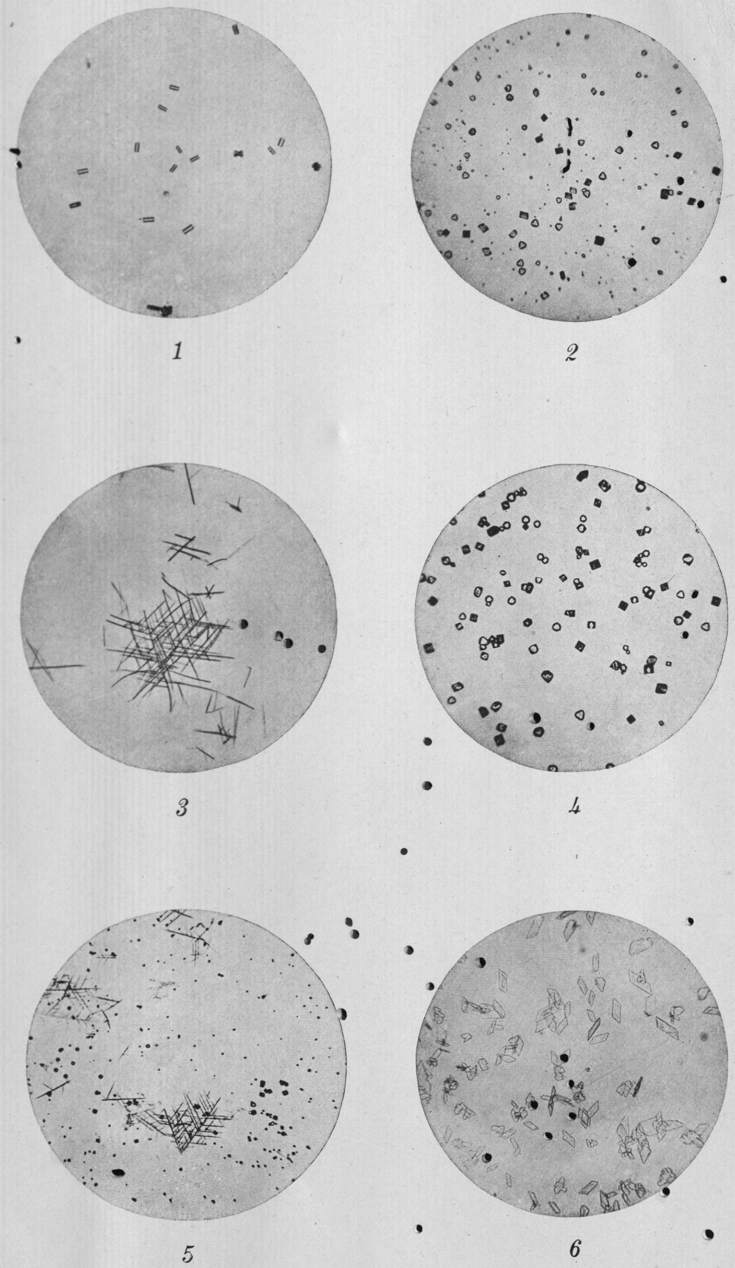
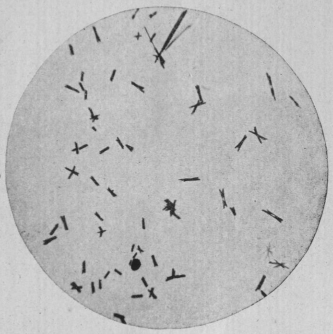


PLATE 1.



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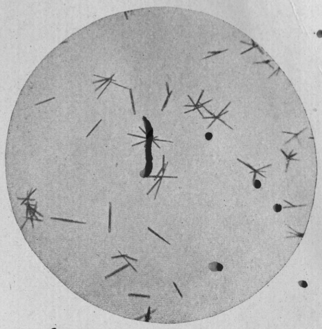

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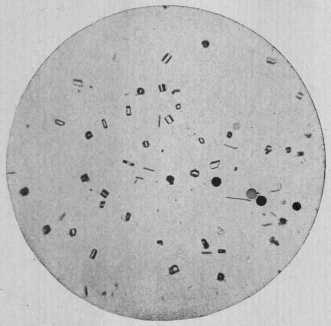

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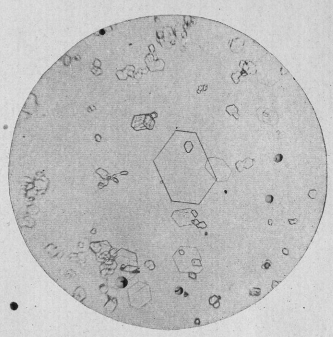

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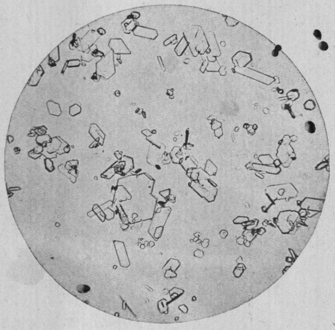

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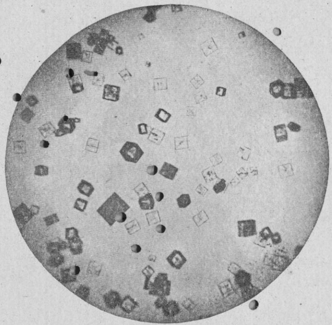

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PLATE 2.

ERRATA

VOLUME 21, NO. 3

Page 324, line 16, *for* Scutellum with three pits *read* Scutellum with two pits.

Page 324, line 22, *for* Oberthürella Kieffer *read* Oberthürella Saussure.

Page 324, in key to the Liopterinæ, as a footnote from Allocynips, *add:*

Mayrella Hedicke (1922) instead of forming a new subfamily seems to be close to *Allocynips* and separated from it by the 12- instead of 13-segmented antennæ of the female.

Page 325, line 1, *for* Malar space one-third eye. *read* Malar space as long as eye.

Page 325, line 4, *for* Malar space as long as eye. *read* Malar space one-third of eye.

Page 326, line 8, *for* Interocular space 0.56 eye. *read* Interocular space 0.56 transfacial and area 1.1 times as broad as high. Malar space 0.56 eye.

Page 331, line 18, *for* 42,25 *read* 42 : 25.

ADDENDUM TO VOLUME 22

On page 80, after paragraph 5, insert the following:

6. The pigs refused to take the raw shredded coconut meat, so that the raw shredded meat was pressed and 10 cubic centimeters of the undiluted juice therefrom was fed through a tube each day. This juice contains very little vitamine since it did not lengthen the life of the pigs appreciably.

7. Ten cubic centimeters of juice expressed from the raw banana-flower bud did not lengthen the span of life.

8. Twenty-five grams of raw Chinese persimmon given daily protected the pig for periods of from seven to sixteen weeks.

9. Thirty grams of raw Chinese persimmon given daily protected two pigs from scurvy for a period of twenty-four weeks and, therefore, this seems to be the minimum amount for complete protection. Pigs 11P and 12P were taken off this diet after the fourteenth week, since we needed them for other purposes.

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